THE *Petroleum* Engineer — Management Edition

Exploration—Drilling—Producing • Refining—Petrochemicals—Gas Processing • Oil and Gas Pipelining

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The New Congress and Oil

The petroleum industry, never without its problems, now finds itself beset by more and graver ones than for many years. Results of the November congressional elections, therefore, are being observed with a keen eye by industry leaders to evaluate the possible effect on these problems by the new Congress. They want to know whether the oil industry will fare better or worse on such matters as the depletion allowance, imports, and the Phillips Case, as a result of changing alignments.

Taking a look at the situation bearing on the Phillips Case, Rep. Sam Rayburn of Texas will again be speaker of the House, and Senator Lyndon Johnson of Texas likely the Senate majority leader. Both strongly advocate legislation to amend the Natural Gas Act to prohibit control of prices by FPC at the production level. Democratic control of the House has also given advocates of such legislation a strong ally in Rep. J. Percy Priest of Tennessee, who is scheduled to become chairman of the Interstate and Foreign Commerce Committee. Defeat of Senator Ferguson of Michigan removed a formidable foe. On the other side of the scale, a serious set-back is the elevation of Senator Warren G. Magnuson of Washington to chairmanship of the Senate Interstate and Foreign Commerce Committee. Some 28 senators who opposed the Kerr Bill are back and 27 who favored it. This may be an indication of things to come, but there can always be shifts in viewpoints.

Rep. Jere Cooper of Tennessee, who will be the new chairman of the House Ways and Means Committee, and Senator Harry Byrd of Virginia, who will be chairman of the companion Senate Finance Committee, have indicated they favor a reduction in the 27½ per cent depletion allowance. In contrast, the present chairmen of those committees, Milikin and Reed, oppose a cut. It is thought, however, that vigorous opposition to any change on the part of Rep. Rayburn and Senator Johnson will offset the loss of these chairmanships.

In the matter of imports, Byrd and Cooper are on record as opposing restrictive legislation. Neither Rayburn nor Johnson has whole-heartedly urged legislation, but well could as they are from the largest oil producing state. Rep. Oren Harris of Arkansas, in line to become head of the House Commerce Committee, is believed to be more favorable to restrictive legislation than his predecessor, Rep. Wolverton of New Jersey. Rep. Patman of Texas, heading the House Small Business Committee, favors import restrictions.

Balancing one factor against another, it appears that the shifting of House and Senate control from the Republicans to Democrats bodes no special catastrophe insofar as the industry is concerned. Frank M. Porter, president of the American Petroleum Institute, has expressed the opinion that the industry could fare even better as a result of predominant committee control by southern conservative Democrats. In any event, he sees no great upheaval. This evaluation might well be the correct one.

All along, the fact has been recognized that the petroleum industry faces a stiff fight during the coming congressional session regardless of its composition politically.

The consensus also is that the most effective weapon at hand is the education of the public on vital issues. With all the facts known it is never so easy for political demagogues to "sell their bill of goods."—*Frank H. Love.*

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The leader has lengthened its lead!

From the day it was announced, the Marsh Mastergauge took the lead in the pressure gauge field. You are probably well aware of this . . . but do you realize that we have constantly given it plus qualities to still further *lengthen* its lead?

Look at the recent developments presented opposite. Unquestionably these are the three greatest strides in gauge development since the creation of the Marsh "Recalibrator."

Yes, the three basic gauge components have been brought to a remarkable stage of perfection in the Mastergauge. Certainly, for every critical service there is no gauge to compare with it!

Mastergauge is standard bearer for the world's broadest line of gauges and dial thermometers, each the best of their kind in the applications for which they are recommended. Ask for data covering your specific needs.

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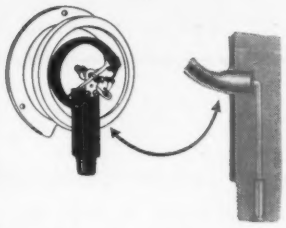
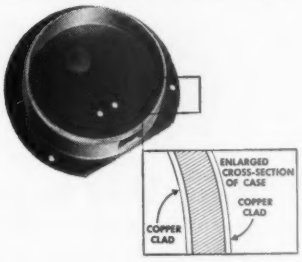


1—A better tube construction—

The Mastergauge always had the most effective joining of the bourdon tube to the socket . . . but . . . *one-piece construction is always better!* Welding these dissimilar parts posed a tough problem . . . but we finally solved it by a new process—the "Conoweld" process—exclusively ours. The photo of an actual section shows the perfect fusion. Socket, tube—even the end-piece—are fused into one leak-tight unit.

2—A better movement—

To convert the action of the bourdon tube into accurate pressure indication, the gauge movement must be rugged, practically frictionless, highly resistant to corrosion. A self-lubricating effect is achieved in the Mastergauge movement by using alternate stainless steel and monel—gears stainless, bushings "K" monel, and so on. A distinguishing feature is the "coined" sector gear. Note broad face of gear which results from this coined extrusion.



3—A better case—

Another development that has increased Mastergauge leadership is the new copper-clad, wrought steel case. The case has the strength of steel and the resistance to corrosion of copper. It is four times as strong as a cast iron case and one-third lighter. Final finish is a handsome corrosion resistant black enamel. Every case is fitted with Marsh safety blow-out plug—a typical advancement.

XUM

HIGHLIGHTS ★ ★ ★

Digest of News and Comment

Appeal Labor Decision

The National Labor Relations Board, by a three to one decision has ordered Richfield Oil Corporation to bargain with the Oil Workers International Union concerning the stock purchase plan which Richfield adopted for its employees a year ago. Richfield officials said that they agreed with the dissenting member of the Board that the stock purchase plain is not a wage or a term or condition of employment and therefore is not within the field of compulsory collective bargaining.

★ ★ ★

Form New Gas Committee

A natural gas and oil resources committee has been formed to acquaint consumers and the general public of the full story of efforts to meet demand for natural gas and oil products. Chairman is L. F. McCollum, president, Continental Oil Company, and vice chairman is Paul Kayser, president of El Paso Gas Company. Director of the committee on information is Baird H. Markham, former head of American Petroleum Industries Committee. Headquarters will be in New York.

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Funds for Drake Museum

The Board of Directors of the American Petroleum Institute has endorsed as a worthwhile project a plan to raise funds by private subscription to expand the Drake Well Memorial Museum at Titusville, Pennsylvania. The fund-raising campaign will be carried out privately by Pennsylvania oil men.

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Royal Dutch Shell Income

Net income of the Royal Dutch Shell group for the first half year, to June 30, 1954, showed an 11 per cent increase. Net income for six months, 1954, in pounds is £69,193,290.

★ ★ ★

Higher Octanes Coming

Oil companies will continue to produce increasingly higher octane motor gasolines, at least for the next 10 years, it was predicted by Dr. J. Bennett Hill, director of research and development for Sun Oil Company. These higher octane gasolines will go hand in hand with higher compression ratio in automobile engines. Dr. Hill foresees no likelihood that turbine engines will replace gasoline engines in passenger cars during this period.

★ ★ ★

Injunction Sought

Stanolind seeks injunctions to prevent the Federal Power Commission from enforcing its order controlling production and pricing of natural gas moving in interstate commerce. The Stanolind suit contends that certain sections of the FPC order exceed agency authority: Requiring the company to seek certificate of convenience for the sale of gas; compelling the company to continue selling gas when the contract specifies that it would be nullified if FPC got authority, etc.

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Iranian Name Changes

Name of the Anglo-Iranian Oil Company, Ltd., will be changed to British Petroleum Company. Company spokesman said the name change reflects the new status of the company, which was the center of the recently settled Iranian oil dispute.

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Mid-East Gas Uses

A report on possible uses of natural gas produced in Saudi Arabia and now being flared, has been made public by the Foreign Operations Administration. Report, made by the National Academy of Sciences and National Research Council, named as a possibility liquefying the gas for transportation in specially-equipped barges to Europe for marketing. This would utilize about 500,000,000 cu ft daily. Also suggested was a 36-in. gas pipe line to Europe.

★ ★ ★

Share Iran Oil?

The Department of State understands that after an oil agreement with Iran goes into effect the U. S. companies presently participating in the consortium will make available shares to other American companies. The U. S. share in the consortium amounts to a total of 40 per cent. It is believed that one-eighth of this 40 per cent or 5 per cent of the consortium will be subject to sale to other American companies. The procedure whereby this share will be made available has not been worked out in final form.

Crude Price Reduced

Ohio Oil Company has announced a reduction in crude oil prices for Illinois and Indiana. Ohio, one of the principal oil buyers in the area, posted a reduction of 7 cents per bbl for eastern Illinois and Western Indiana crude to $2.95 per bbl for 35 gravity and above, with a 2-cent differential downward to $2.81 for below 29 gravity. Illinois Basin flat price was set at $2.95; the Plymouth, Illinois flat posting, $2.62.

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Bradley Buys Condor Stock

Bradley Oil Company, Dallas, Texas, has purchased 3107½ more shares of capital stock of Condor Petroleum Company, Abilene, Texas. This gave Bradley a total of 5004½ shares, 75 per cent of the 6689 shares out. Total consideration in the transaction was $19,517,550. Bradley is a wholly owned subsidiary of San Juan Exploration Company of Dallas.

★ ★ ★

Anti-Knock Price Down

Prices on anti-knock compounds for gasoline have been reduced for the third time this year by Du Pont Company and Ethyl Corporation. Du Pont's domestic price, including Canada and Mexico, for its motor mix compound went down a cent a pound to 36.70 cents. Its aviation mix compound dropped from 41.268 cents a pound to 40.28. Ethyl has announced corresponding reductions. Previous price reductions were made in March and May.

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Review of Gas Price Case

The U. S. Supreme Court will rule on whether Oklahoma has the right to regulate prices charged for natural gas sold to interstate pipe lines. It will review decisions upholding Oklahoma's regulation of minimum prices on natural gas from the Guymon-Hugoton field. Natural Gas Pipeline Company of America, Michigan-Wisconsin Pipe Line Company, and Panhandle Eastern Pipe Line Company appealed, contending that the state had invaded jurisdiction of FPC to regulate natural gas sales and that the state regulation interfered with interstate commerce.

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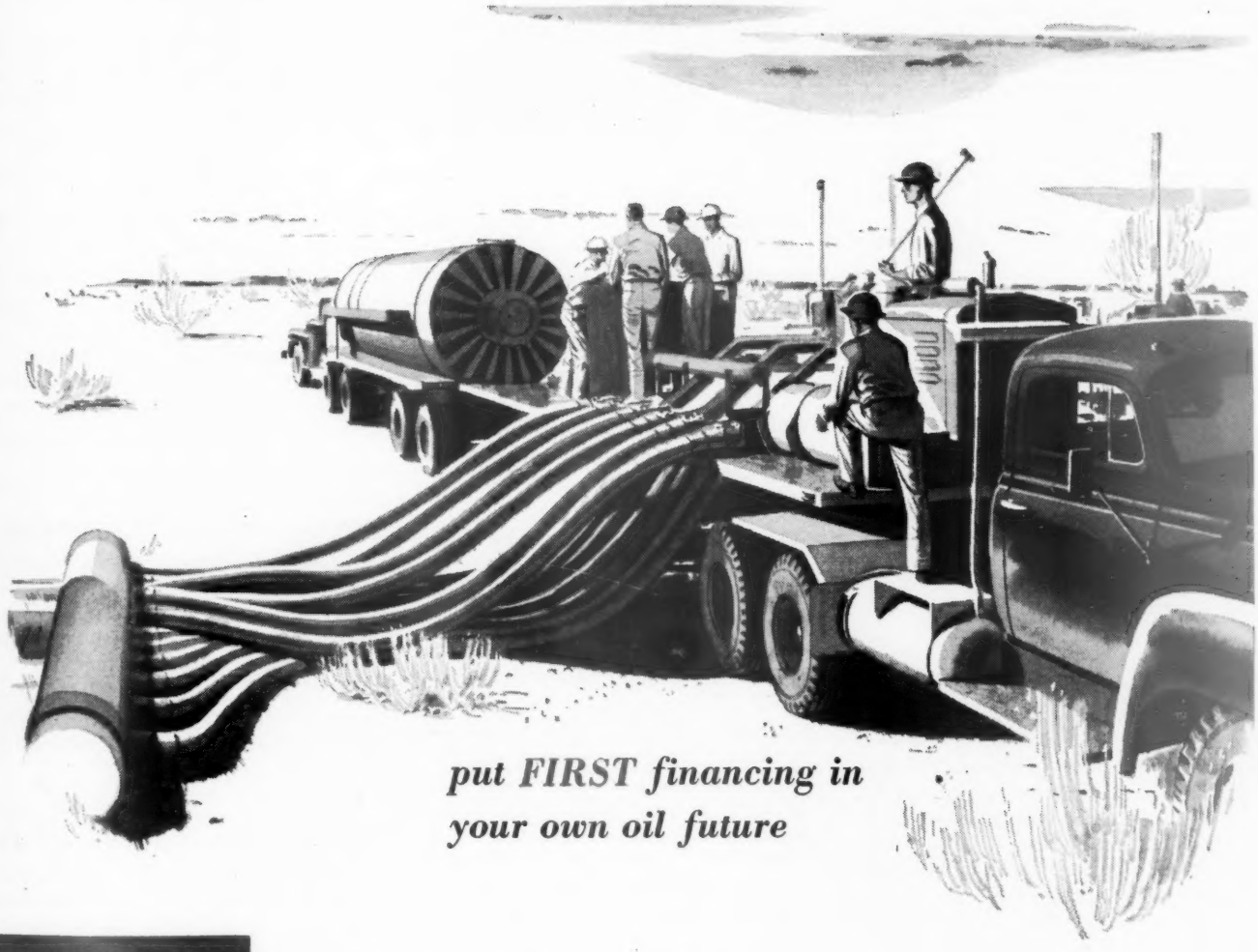
No. 3 J. Timken.. ready for the big frac

and a Loan From the FIRST Closed the Deal



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MEMBER FEDERAL DEPOSIT INSURANCE CORPORATION

Road Financing Studied

Acting on the theory that penalties of an obsolete road system are large and that the price of inefficiency is paid in dollars, lives, and national security," a presidential advisory committee has made recommendations for financing Eisenhower's road-building program. Th President's proposal that an additional $50 billion be spent over the next 10 years to speed up road building exceeds by $54 billion the presently available revenues.

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Britain Using More Oil

British oil consumption, excluding ships bunkers, was up 10 per cent over the first half of 1953. It totaled 10,287,-252 tons from January through June, 1954.

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New Discoveries Needed

If the Americans are to keep their high standard of living, new oil must be discovered every day, says George R. Bryant, vice president of The Texas Company. "The only way this day-in-day-out search for new crude oil sources is possible is through the 27½-per cent depletion allowance," he stated. If we do not provide for the replenishment of our resources (the equivalent of the 10 million bbl of oil that we use each day) our standard of living must certainly fall, and with it our security, he added.

★ ★ ★

Oil to Korea

More than 65 per cent of the tonnage shipped overseas during the Korean conflict consisted of petroleum and petroleum products, according to Maj. Gen. Paul F. Yount, U. S. Army Chief of Transportation. Winning World War II cost almost seven billion bbl of oil, Yount said. "In World War II the volume of machine food—liquid fuel—shipped overseas was actually about 16 times that of the soldier's ration," he added.

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Atomic School

The United Kingdom Atomic Energy Authority has a three months' training course at Harwell, England. The Reactor School admits only physics and engineering graduates from industrial concerns.

A. E. Chester, Magnolia Petroleum Company vice president and manager of producing, left, listens to his company's chief pilot, Sam J. Willis, center, explain the controls of a Bell helicopter. The aircraft will be used to move personnel and light supplies between Beaumont and the company's first Texas offshore wildcat some 8½ miles at sea. Looking on at right is M. W. Patterson, company treasurer. Magnolia is the first oil company in the U. S. to operate its own helicopter service.

★ ★ ★

Magnolia Given Stay

Magnolia Petroleum Company and Ohio Oil Company have been granted stays from FPC's order No. 174-A, which regulates natural gas producers, by the U. S. Court of Appeals, Fifth Circuit. Stays are first to be given gas producers since FPC issued the order in August, following Supreme Court ruling that the commission has jurisdiction over sales of producers of natural gas moving in interstate commerce. Stays were issued pending final hearings on the companies' separate petitions that the FPC order be set aside.

★ ★ ★

Refinery for South Dakota

Great Plains Refinery and Development Company has announced plans to build South Dakota's first refinery. The $3,000,000 refinery will be built in Rapid City. Arthur Gordon, Great Plains president, said that construction of the refinery will be financed by sale of stock, debenture bonds, and extension of one million dollars credit by a major oil industry supply house.

API Publishes Standards

A new standard of *Measuring, Sampling and Testing of Crude Oil and Petroleum Products* has been published by the American Petroleum Institute.

To be known as Standard 2500, it will replace, in part API Code 25, Seventh Edition, dated June, 1948. API President Frank M. Porter announced the standard will become effective January 1, 1955. This is the first time an API group has included automatic equipment which may be used in the custody transfer of crude oil. Remaining material in the Standard has been reviewed completely, and rewritten so as to include various methods of measuring, sampling, and testing employed for crude oil and products, and used in different sections of the country.

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Canadian Crude Output Up

Canada's 1954 crude oil output is expected to show an increase of 15 per cent, approximately 93,000,000 bbl, over 1953 production. Production in 1953 was 30 per cent over the previous year. Pipe line construction in Canada is expected to break all records in 1955.

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Mines Bureau Reorganizes

The U. S. Bureau of Mines is reorganizing its health, safety, and coal mine inspection activities into separate divisions. Each activity will be handled separately beginning January 1. New divisions are being created for health and safety; there will be 8 districts and 12 sub-districts under the change.

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Record Attendance at API

Registration for the 34th annual meeting of the American Petroleum Institute totaled 6550, setting a new record. Previous record was made in 1952, with 6392 registrations.

★ ★ ★

More Motors Running

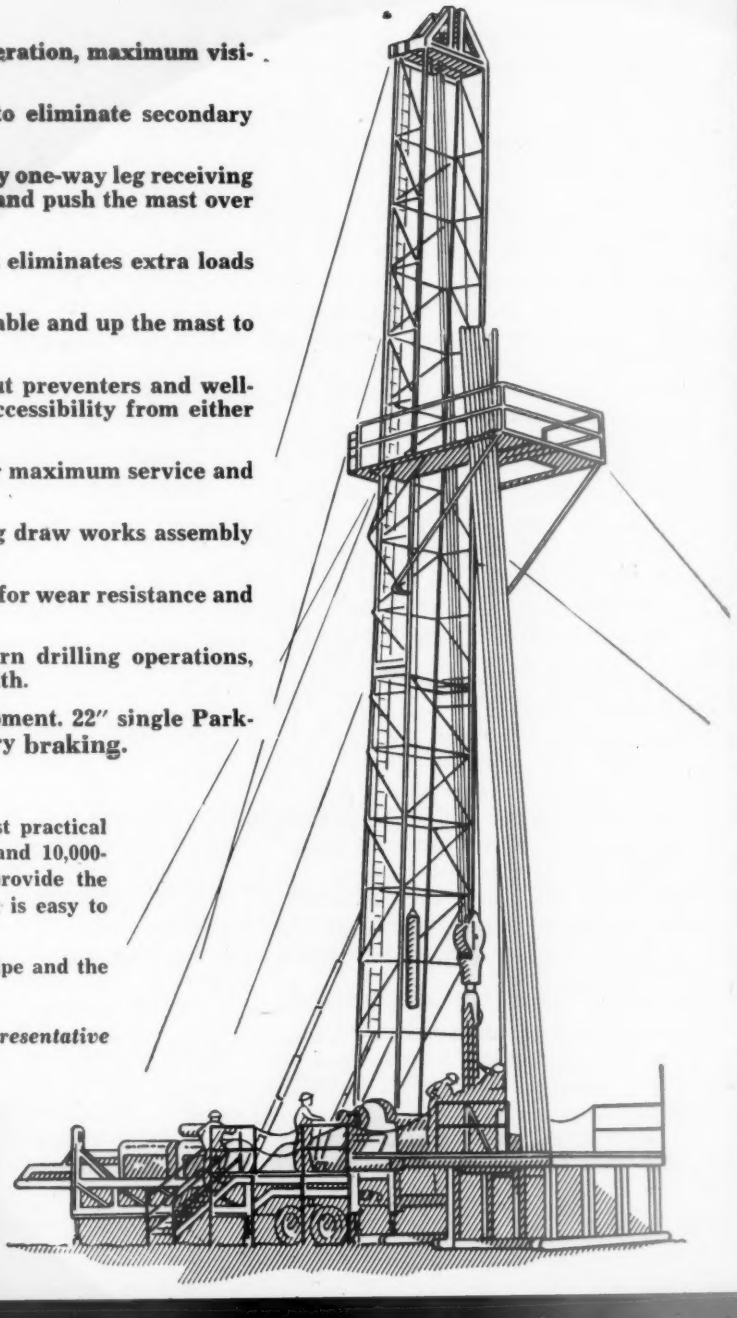
Our State Department reveals one clue to increase in foreign oil demand. Motor vehicles in Belgian Congo increased from 31,984 in 1951 to 43,335 in 1953, more than 35 per cent in 2 years; in Indonesia motor vehicle registrations have reached 164,328, an 80 per cent increase since 1951.

CARDWELL "TRAILERIG"

IS 15 WAYS BETTER

...than any comparable rig

1. **Mud Pump Drive is driven by draw work's engines through a Cardwell air friction clutch, which is capable of handling the full horsepower of the rig. Full horsepower of the rig can be used for hoisting and for driving the rotary and pump when drilling. Moving and rigging up is simplified with this built-in mud pump drive.**
2. **"Trailerig" with two engines is within eight feet road width for maximum portability regardless of the overall length of the engines. Placement of engines eliminates eccentric loading and engine overhang.**
3. **Truss-type trailer frame gives exceptional strength and rigidity with minimum weight.**
4. **All rig assemblies are easily accessible.**
5. **Catheads are located ahead of driller for ease of operation, maximum visibility and safety.**
6. **Single chain rotary drive is placed well forward to eliminate secondary chain drives to table.**
7. **One-way rams erect the mast and are supplemented by one-way leg receiving rams which support the mast as it goes over center and push the mast over center when lowering.**
8. **No trailer ramp is needed with the "Trailerig"; this eliminates extra loads and rig-up time.**
9. **Driller has maximum visibility, both to the rotary table and up the mast to the racking platform and crown.**
10. **Ample space is provided under platform for blowout preventers and wellhead connections without using ramps. Complete accessibility from either side.**
11. **Crown sheaves are mounted on Timken bearings for maximum service and life.**
12. **"Trailerig" is a completely unified design combining draw works assembly and telescoping mast with trailer frame.**
13. **Every wearing part of the "Trailerig" is heat-treated for wear resistance and long service life.**
14. **Two-engine drive gives power necessary for modern drilling operations, yet the "Trailerig" does not exceed 8-foot road width.**
15. **Circulating water-cooled brakes are standard equipment. 22″ single Parkersburg Hydromatic brake is available for auxiliary braking.**



This Cardwell "Trailerig" has proved to be the most practical and profitable rig available for 5,000-foot drilling and 10,000-foot workover jobs. It is designed and built to provide the modern drilling contractor with a complete rig that is easy to move and rig-up, and fast in operation.

With the addition of a mud pump, a string of pipe and the usual tools, the "Trailerig" is ready to drill.

Write today for catalog and prices, or see nearest Cardwell representative

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Petroleum Profile

ONE week he'll be in Cincinnati for the opening of a new asphalt refinery, then it's back to Taft, California, for a civic celebration. The day after, it's New York, after a stop-over at Houston. And in between, there's a succession of decisions to make at the home office in San Francisco.

For T. S. (Ted) Petersen, president of Standard Oil Company of California, this busy schedule has become as routine as his daily commuter's circuit to and from the office.

In a near-lifetime of selling petroleum, Ted Petersen has clocked enough mileage to girdle the globe a dozen times. Experience taught him long ago that in the selling game you can't be a stay-at-home.

Standard's president began learning this lesson at the pump block of one of the company's service stations 32 years ago. In the 3 decades since, he's put it to use on some 22 different assignments that have taken him throughout the company's marketing territories.

Since he stepped up to the presidency, Petersen now ranges the country—and occasionally other parts of the world—overseeing the company's whole scope of activities. But whatever the nature of his duties, he tries to handle them with the same direct, face-to-face approach that he developed as a salesman and personnel man.

Petersen was born in Logan, Utah, in 1896, later moved to Portland, Oregon, with his family. As a student at Portland's Washington High, he played football and basketball and was elected president of the student body.

He also went out for debating, an experience that was to become increasingly useful later on. In an average year he'll probably make a dozen major speaking appearances and reluctantly have to turn down that many more.

Back from a term of military training in World War I, Petersen decided Standard's growing organization offered a young man plenty of opportunity for advancement. It turned out to be a wise decision. After six months on the station pumps, he moved into a white-collar assignment and began climbing the ladder.

By the mid-thirties he was in the management of Standard Stations, Inc., the company-owned stations, and in 1938 was appointed general manager of the chain.

Transferred to the parent company later that year, Petersen served successively as assistant to the president and manager of employee relations; assistant general sales manager, and manager of the marketing department.

T. S. PETERSEN
President
Standard Oil Company of California

In June of 1942 he was elected to the board of directors and the following December was elevated to vice president. He has been president of Standard of California since January 8, 1948.

Petersen is an active member of the Secretary of Commerce's Business Advisory Committee and served as one of the hosts when that group met on the West Coast this year. Recently, also, he headed the California business delegation to President Eisenhower's White House Conference on Traffic Safety.

For some years he has figured in the affairs of the American Petroleum Institute and is currently chairman of the committee which selects the recipient of the Institute's annual Gold Medal Award for distinguished service to the industry.

As consulting professor of marketing to Stanford's Graduate School of Business, Petersen makes an annual presentation reviewing his company's history and progress. He has also lectured on U. S. foreign trade to the school of business at the University of Southern California.

What time he has for personal recreation, Petersen likes to devote to his garden at home in suburban Hillsborough, an occasional golf game, or foray after ducks.

Meetings

Dec. 8-10—**Oil Industry Information Committee,** Waldorf-Astoria Hotel, New York, New York.

Dec. 12-15—**American Institute of Chemical Engineers,** annual, Statler Hotel, New York, New York.

Dec. 27-30—**American Association for the Advancement of Science,** University of California, Berkeley, California.

1955

Jan. 10-14—**Society of Automotive Engineers,** annual meeting and engineering display, Sheraton-Cadillac Hotel and Hotel Statler, Detroit, Michigan.

Jan. 17-18—**Kansas Oil Men's Association,** annual, Baker Hotel, Hutchinson, Kansas.

Jan. 17-19—**Pipe Line Contractors Association,** Statler Hotel, Los Angeles, California.

Jan. 20-21—**National Industrial Conference Board,** Hotel Astor, New York, New York.

Jan. 24-26—**Plant Maintenance and Engineering Conference,** annual, International Amphitheatre, Chicago, Illinois.

Jan. 24-27—**American Society of Heating and Ventilating Engineers,** annual, Philadelphia, Pennsylvania.

Jan. 26-28—**Symposium on Instrumentation for Process Industries,** Texas A&M College, College Station, Texas.

Jan. 27-28—**American Chemical Society,** Southeastern Texas section, symposium on hydrocarbon chemistry, Houston, Texas.

Feb. 10-12—**Institute of Radio Engineers Conference and Electronics Show,** Baker Hotel, Dallas, Texas.

Feb. 13-17—**American Institute of Mining and Metallurgical Engineers,** annual, Conrad Hilton Hotel, Chicago, Illinois.

Feb. 13-18—**American Society for Testing Materials,** Committee D-2 on Petroleum Products and Lubricants, Rice Hotel, Houston, Texas.

Feb. 14-16—**American Association of Petroleum Geologists,** Rocky Mountain regional, annual, Billings, Montana.

Feb. 16-18—**National Association of Corrosion Engineers,** annual short course for pipeliners, Mayo Hotel, Tulsa, Oklahoma.

Feb. 25—**Natural Gasoline Association of America,** Permian Basin regional, Scharbauer Hotel. Midland, Texas.

March 7-11—**National Association of Corrosion Engineers,** Palmer House, Chicago, Illinois.

March 9-11—**American Petroleum Institute,** Southwestern District, Division of Production, Jung Hotel, New Orleans, Louisiana.

NOMADS TO MEET

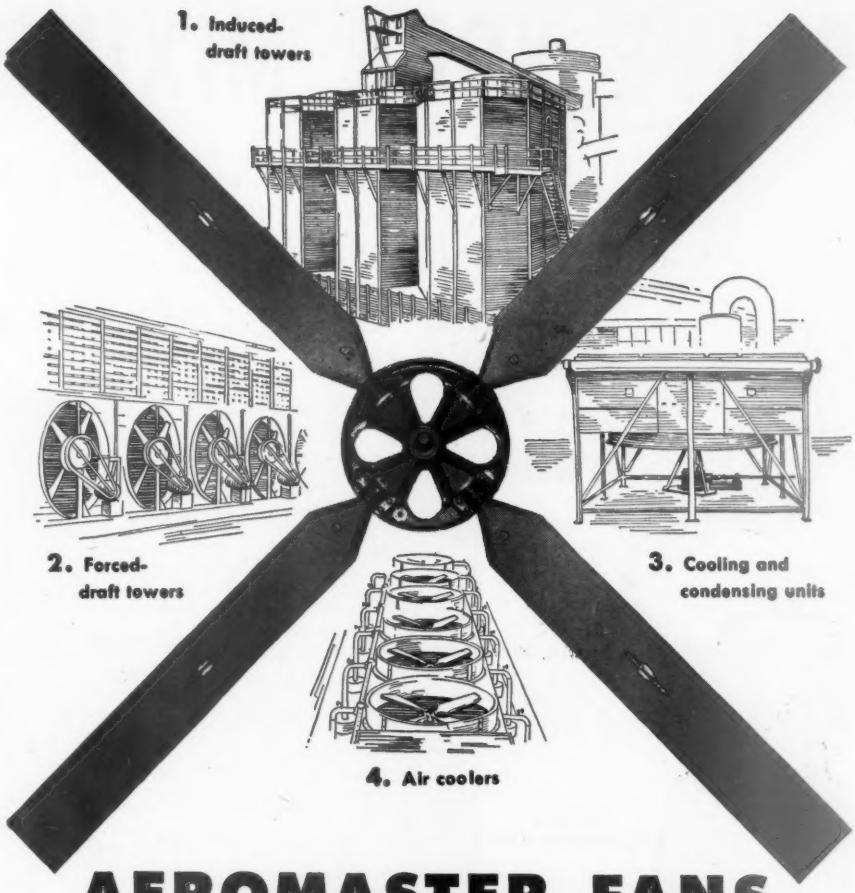
New York, N. Y., Chapter, First Monday of the Month, Biltmore Hotel, New York. Secretary, O. B. Latrobe.

Houston Chapter, Second Monday of the Month, Ye Olde College Inn, Houston, Texas. Secretary, Harry E. Estes.

Los Angeles Chapter, Second Wednesday of the Month, Jonathan Club, Los Angeles, Calif. Executive Secretary, Wallace A. Sawdon.

Tulsa Chapter, Third Friday, "After Five" Room, Hotel Tulsa. Secretary, Gilbert Swift.

Dallas-Fort Worth Chapter, Dallas, Texas. First or Second Monday of the Month. Secretary, Glen Tableman.



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March 20-23—**American Institute of Chemical Engineers,** Kentucky Hotel, Louisville, Kentucky.

March 24—**National Industrial Conference Board,** Shamrock Hotel, Houston, Texas.

March 24-25—**American Gas Association,** gas supply, transmission, and storage conference, William Penn Hotel, Pittsburgh, Pennsylvania.

March 27-29—**Texas Independent Producers and Royalty Owners Association,** annual, Hotel Texas, Fort Worth, Texas.

March 28-31—**New York Oil Finders Convention,** the American Association of Petroleum Geologists, the Society of Economic Geophysicists, and the Society of Economic Paleontologists and Mineralogists, annual, Statler Hotel, New York City, New York.

March 28-April 1—**Ninth Western Metal Exposition,** American Society for Metals and 19 other technical societies, Ambassador Hotel, Los Angeles, California.

April 13-15—**Natural Gasoline Association of America,** annual, Baker and Adolphus Hotels, Dallas, Texas.

April 13-15—**American Society of Lubrication Engineers,** annual, Hotel Sherman, Chicago, Illinois.

April 19-21—**Southwestern Gas Measurement Short Course,** University of Oklahoma, Norman, Oklahoma.

May 1-4—**American Institute of Chemical Engineers,** Shamrock Hotel, Houston, Texas.

May 1-4—**Liquefied Petroleum Gas Association,** annual, Conrad Hilton Hotel, Chicago, Illinois.

May 9-10—**American Gas Association,** gas supply, transmission and storage conference, Hotel William Penn, Pittsburgh, Pennsylvania.

May 9-12—**American Petroleum Institute,** midyear meeting, division of refining, Jefferson Hotel, St. Louis, Missouri.

May 14-22—**Deutsche Gesellschaft fur Chemisches Apparatewesen,** (worldwide chemical plant and equipment exposition), chemical plant and apparatus exhibition and congress, Frankfurt am Main, Germany.

May 16-18—**American Petroleum Institute,** division of transportation, midyear committee conference, Edgewater Beach Hotel, Chicago, Illinois.

May 19-20—**National Industrial Conference,** Waldorf-Astoria Hotel, New York, New York.

June 3-5—**Desk and Derrick Seminar,** sponsored by Dallas Club for Regions 4 and 5, Southern Methodist University, Dallas, Texas.

June 5-9—**Canadian Gas Association,** annual, Sheraton-Brock Hotel, Niagara Falls, Ontario, Canada.

June 6-10—**American Petroleum Institute,** division of production, midyear committee conference, Brown Palace Hotel, Denver, Colorado.

June 6-15—**Fourth World Petroleum Congress,** Rome, Italy.

June 9-10—**Pennsylvania Grade Crude Oil Association,** Hotel William Penn, Pittsburgh, Pennsylvania.

June 9-10—**Natural Gas and Petroleum Association of Canada,** Royal Connaught Hotel, Hamilton, Ontario, Canada.

June 12-17—**SAE Golden Anniversary Summer meeting,** Chalfonte Hadden Hall, Atlantic City, New Jersey.

June 16-18—**Interstate Oil Compact Commission,** Cosmopolitan Hotel, Denver, Colorado.

June 28-July 1—**American Society for Testing Materials,** Chalfonte-Hadden Hall, Atlantic City, New Jersey.

Sept.—**American Association of Desk and Derrick Clubs of North America,** annual, New York, New York.

WE'VE HAD IT!

Worst Economic Dip Believed To Be Over

The Future Looks Brighter

ERNESTINE ADAMS*

FINANCIAL reports for the first three quarters of 1954 showed the majority of oil companies with higher gross income than 1953 but most of them this year did not meet their net income for the first nine months of 1953.

The dip was lowest in the third quarter. If most economists are right, this was the low point for the remainder of this year and for 1955. Indications give solid basis for improvement both in the overall economy and in the oil industry.

Interesting point is that, although more than two-thirds of those making reports showed less net profit than in 1953, at least 2⅓ times as many had a net profit greater than in 1952. Profits, on the whole, were somewhat off from the record high made in 1953 but still above the second high year of 1952. After a more successful fourth quarter, the year's net return may still top 1953. There is little question that 1954's gross income for the industry will hit the all-time record.

Various explanations for the dip in business were given but the prime one was reduction in production brought about by state allowable cuts.

Standard Oil Company (Ohio) stated: "Sales and operating revenue declined 7 per cent. This was primarily due to a substantial drop in the physical volume of unbranded products sold in wholesale markets. In addition, reduced industrial activity adversely affected the demand for residual fuel oil, coke and other industrial products. However, Sohio achieved a 3 per cent gain in the quantity of light refined products sold through usual marketing channels.

"As a result of the reduced physical volume, operating costs were 6 per cent lower for the 9-month period. However, this decline only partially offset the loss in revenue and was also proportionately less than the reduction in volume."

Middle States Petroleum had this to say: "Decrease in gross and net income resulted largely from drastic reductions in allowable production which are still in effect and are likely to continue during the last quarter of the year, with expected similar effect upon gross and net income for the last quarter."

Although Sinclair Oil Corporation has an increase for the 9-month period, it had a 5 per cent decline in the third quarter. Its report pointed out that in Texas there "were 46 'allowable' producing days in the third quarter of 1954 against 61 such days in the similar 1953 period."

Proration and other items were mentioned in the report of Standard Oil Company (Indiana). "Decrease in earnings for the 9 months was due principally to a decline of 9.5 per cent in the company's net crude production as a result of reduced allowables in most states, a sharp decrease in sales of aviation gasoline to the military, and increased amortization charges. Other factors reducing earnings were relatively low refinery runs and product prices, especially in the third quarter."

Skelly Oil Company, despite a small decrease in earnings, approved the regulations with this comment: "Permissible crude oil production continued to decline as restrictions imposed by state proration boards increased in severity. It is believed that over-production of crude oil by the industry is being met and gradually overcome by this kind of drastic but wholesome and constructive state regulation."

The third quarter dip was explained by Phillips Petroleum Company: "Earnings in the third quarter of this year were affected to a greater extent by lower allowable crude oil production rates common to the industry, reduction of refinery output to maintain gasoline inventories in line with slackened demand in the spot market, and scattered weakening of product prices in local areas."

In its report for the year ending June

*Management Editor.

EXCLUSIVE

FINANCIAL REPORTS FOR FIRST NINE MONTHS OF 1954

Name of company	Gross income 9 mo., 1954 $000	Gross income 1953 $000	Per cent change from 1953	Net income 9 mo., 1954 $000	Net income 9 mo., 1953 $000	Per cent change from 1953	Per common share net income 1954	Per common share net income 1953	Price per share Sept. 1954	Price per share Dec. 1953
Amerada	61,617	63,543	— 3	11,657	12,962	—11	3.70	4.11	181½	165
Anderson-Prichard	41,399	38,983	+ 6	2,535	3,368	—25	3.12	4.14	44½	43⅛
Argo Oil	7,808	7,001	+12	3,310	3,333	— 1	1.66	1.67	24	18
Ashland O & R	172,503	177,884	— 3	5,124	7,736	—51	.72	1.21	12¾	11⅝
Atlantic	433,395	447,215	— 3	26,401	33,062	—25	2.84	3.58	34¾	28
Bishop	1,361	1,332	+ 2	160	178	—11	.43	.48	11¾	11
Cities Service	619,459	644,727	— 4	30,911	37,715	—18	7.95	9.70	107¼	78
Continental	373,502	358,698	+ 4	31,337	31,163	+ 1	3.22	3.20	71	52
Cosden Pet	35,722	34,068	+ 5	2,423	2,179	+11	2.34	2.69	19¾	15⅞
Deep Rock[5]	29,962	31,099	— 4	2,416[5]	1,024	+136	5.24	2.28	46½	35⅛
Derby Oil*	17,312	16,424	+ 5	745	961	—29	1.60	2.07	24¾	16⅛
General American[1]	13,922	13,667	+ 2	6,573	5,388	+22	5.49	4.71	48¼	40½
Gulf Oil	.....	1,205,000	....	116,359	116,828	± 0	4.74	4.76	61½	46¼
Hancock	32,618[3]	38,153[3]	—17	5,106	12,029	—136	1.62	3.86	28¼	20
Honolulu	22,837	21,944	+ 4	8,129	7,712	+ 5	4.33	4.11	71¼	57
Houston Oil	24,029	24,010	± 0	4,308	5,002	—16	3.23	3.77	77¾	66¾
Hugoton Production	3,133	2,982	+ 5	1,485	1,244	+19	1.75	1.46	45½	40
Husky[1]	13,741	9,057	+52	1,004	587	+71	.34	.17	7	6
Kerr-McGee[1]	32,371	32,339	± 0	2,360	2,669	—13	1.86	2.12	41¼	41
Lion Oil	73,552	68,158	+ 8	7,588	7,450	+ 2	2.45	2.41	41⅞	29⅞
La. Land & Exp	18,778	16,764	+12	10,579	8,017	+32	3.55	2.69	74¾	51⅜
Maracaibo	1,500	1,525	— 1	341	324	+ 5	.69	.65	9¼	7
Mid-Continent Pet	122,276	128,004	— 5	9,795	10,626	— 8	5.25	5.72	93½	66
Middle States	8,310	8,571	— 3	1,662	1,901	—14	.72	.82	12¾	12⅜
Monterey Oil	5,18[9]	5,288	— 2	553	1,912	—247	.43	1.72	34⅝	33⅜
Ohio Oil	187,218	181,267	+ 3	28,281	33,025	—17	4.31	5.03	65½	53¾
Pacific Western	10,668	8,796	+21	5,276	8,969	—70	.93	1.64	33¼	31⅛
Panhandle Oil	9,802	9,682	+ 1	658	664	— 1	.41	.42	7¼	6
Phillips Pet	586,779	565,702	+ 4	55,615	55,458	± 0	3.80	3.80	62¾	53½
Plymouth Oil	68,623	73,442	— 7	4,930	6,744	—37	2.05	2.81	28	23⅝
Pure Oil	.....	.....	....	20,829	18,518	+12	4.71	4.14	62½	46⅜
Quaker State	33,68[2]	37,310	—11	1,480	1,534	— 4	1.79	1.66	25⅛	21⅝
Richfield	159,794	149,190	+ 7	18,278	19,359	— 6	4.57	4.84	57⅜	48
Seaboard	29,078	28,803	+ 1	5,346	5,214	+ 3	1.46	1.43	37½	29½[4]
Shamrock Oil & Gas	28,305	25,049	+13	5,473	4,184	+31	3.65	2.82	49⅝	40¼
Shell Oil	975,711	933,476	+ 5	89,545	81,481	+10	3.26	2.97	56	38½[4]
Signal	.....	.....	....	6,709	6,327	+ 6	1.88	1.78	26¼	19¾
Sinclair	741,539	683,478	+ 8	52,896	47,506	+11	4.29	3.87	46⅛	31¾
Skelly	156,312	164,564	— 3	20,933	22,600	— 8	3.64	3.93	45½	35½
Socony-Vacuum	1,185,400	1,189,900	± 0	128,000	133,000	— 4	3.65	3.80	48¼	35½
Standard California	904,366	859,382	+ 5	154,921	140,217	+10	5.15	4.66	75¾	52⅞
Standard Indiana	1,240,428	1,284,546	— 4	81,444	88,634	— 9	5.24	5.76	92⅞	68½
Standard Jersey	4,235,000	4,156,000	+ 2	438,000	432,000	+ 1	7.23	7.13	100	72
Standard Ohio	236,855	252,157	— 6	12,385	14,198	—15	2.93	3.38	41⅜	32
Sun Oil[3]	328,343	322,115	+ 2	20,407	21,659	— 6	2.64	3.03	78½	69¾
Sunray Oil	94,200	105,445	—12	15,900	18,900	—19	1.51	1.84	19⅜	16⅛
Superior[1]	77,421	73,136	+ 6	10,360	12,000	—16	24.53	28.36	725	650
Texas Company	1,228,076	1,193,823	+ 3	151,880	133,353	+14	5.53	4.85	79	57⅝
Texas Gulf Prod	9,710	8,218	+18	3,813	2,912	+31	3.12	2.63	89½	39
Texas Pacific C & O	16,201	16,039	+ 1	5,697	5,684	± 0	3.21	3.21	45	34¾
Tide Water Associated	338,289	349,232	— 3	26,967	26,915	± 0	2.01	2.00	24½	20½
Toklan Royalty	941	868	+ 8	238	169	+41	.27	.20	4⅛	4⅛
Union Oil of Calif	266,038	238,207	+12	27,151	28,007	— 3	3.98	4.11	49¼	38½
Union Sulphur & Oil	13,921	15,333	—10	936	1,306	—40[6]	1.05	1.95	44	37¾
Universal Consolidated	2,949	4,117	—40	1,201	1,803	—50	1.99	3.09	63	58
Warren Pet	89,680	90,753	— 1	6,387	7,602	—16	3.76	4.47	38⅜	30⅛
Wilcox Oil	7,496	6,636	+13	437	708	62	1.56	2.52	22½	21¼
Woodley Pet	2,405	2,144	+12	482	437	+10	.58	.59	40	33

*Now merged with Colorado Oil and Gas Corporation.
[1]Period of 1 year ending June 30.
[2]6-month period ending June 30, 1954.
[3]Dividends from affiliates were $3,133,000 in 1954; $10,229,000 in 1953.
[4]Adjusted.
[5]Includes sales of oil properties.
[6]In 1953 earned $201,172 in steamship operations; lost $32,991 in 1954.

30, General American Oil Company of Texas blames imports: "The domestic oil industry, as previously pointed out, has been hampered throughout the year by foreign imports at high rates, high inventories, particularly of products, and the resulting severe curtailment of production. This condition has not improved, but is at present more acute than ever."

Products prices get the credit for the third quarter drop by Lion Oil Company: "Prices of principal refined petroleum products during the quarter continued at a point substantially below the level of a year ago. There was an increase in mid-1953 as a result of an advance in the cost of crude oil. Since that time crude oil has held firm but refined oil prices have been reduced because of excessive inventories throughout the industry."

All Divisions Down

The report of the integrated company of Mid-Continent Petroleum Corporation set down the decrease in each step:

"State allowables in Oklahoma, Texas and Kansas, where the greater part of the corporation's production is located, were reduced substantially during the year resulting in lower crude production, decreased pipe line runs and a curtailment of drilling operations. Excessive stocks of gasoline and other petroleum products throughout the United States have resulted in lower prices for most of the principal products. Refinery runs have been curtailed to avoid further excessive accumulations and although the situation is gradually improving, these factors materially affected earnings in the first nine months of this year." This occurred despite gains at the company's own bulk and service stations.

The fact that Houston Oil Company had greater productive capacity in 1954 than in 1953 was not enough to offset allowable production. Its report shows that producing days in Texas were reduced 19 per cent in the first 9 months of 1954. Houston Oil also had higher dry hole costs and depreciation charges in line with its expanded exploration and development program.

One of the companies to show an increase for the first 9 nine months (14 per cent) was Pure Oil Company. This was in spite of a third quarter decline. Its report stated crude oil production was off about 7 per cent from the same period in 1953.

Net income for 1954 over 1953 for Socony-Vacuum increased $2 million for the first quarter, decreased $2 million the second quarter and decreased $5 million the third quarter compared to same period in 1953. Reason was "lower allowable crude oil production, combined with higher costs and lower selling prices."

Exploration Costs Up

Ohio Oil Company, with about the same gross income, had a lower net for 1954. "This reduction resulted primarily from increased costs of an accelerated exploration program, lower crude oil production, and depressed prices for refined products," the report stated.

The fact that costs of developing reserves were increasing was brought out by Continental Oil Company's report, which stated: "Under the accounting practice followed by Continental Oil Company, intangible development costs incurred in drilling all oil and gas wells are charged against current earnings. Such costs for the third quarter of 1954 amounted to $10.8 million compared with $8.4 million for the third quarter of 1953.

"For the first 9 months of 1954, intangible development costs totaled $26.5 million as compared with $20.3 million for the same 1953 period.

"The higher per well intangible development costs in 1954 were caused by drilling wells to a greater average depth, by a larger proportion of wells drilled in offshore areas and by a substantial increase in exploratory drilling activities. These higher outlays for drilling reflect the constantly rising

Total gross income of petroleum industry, total net income, and capital expenditures expected to make new records in 1954 but indications are that per cent return on $18 billion investment will drop for third straight year.

costs of finding and developing production."

*Barron's** points out that producing companies must be more aggressive in their search for oil or lose out to larger firms. "The least aggressive company," reads this opinion, "at times could show the best gain in earnings (since World War II) because it was spending less to look for oil."

Competition Heavy

Several reports mentioned curtailment, adjustments, or expansion because of competition. This year has seen competition, always tough in the oil industry, a stronger force than it has been since pre-World War II days.

Atlantic Refining Company sold its marketing subsidiaries in the Eastern Hemisphere to Anglo-Iranian Oil Company for some $28 million net to be paid by deliveries of crude oil. Atlantic's report emphasized that the countries involved in the agreement could be more economically served by other companies, such as Anglo-Iranian, with Middle East crude and local refineries.

Refinery operations were curtailed by Ashland Oil and Refining Company, its report said, the idea being that the company withdraw from competition involving less profitable business.

Sunray Oil Corporation reported: "Capital expenditures by Sunray and its affiliates for these new facilities have effected an improvement in Sunray's ability to meet competition within the industry and furnish a stronger position for future growth." This mention of the advantages of improved plants was repeated in several other reports.

Cosden's report points out that its hydrofluoric acid alkylation unit and related facilities for producing aviation gas went on stream in July, accounting for increase in earnings.

Release Annual Reports

Included with the 9-month statements in the accompanying table are 4 full year and one 6-month report. General American, Husky, Kerr-McGee, and Superior released their annual reports after June 30, 1954. Sun Oil does not give quarterly reports.

Superior spent almost $6 million more in 1954 for development of oil reserves than in 1953. This paid off with 53 more producing wells than last year and only 8 more dry holes. Total net wells completed were 305 or 33 per cent more than in 1953.

A small integrated firm—Husky Oil Company—continued to climb with a 52 per cent increase in gross and a 71 per cent increase in net income. Against the trend Husky's crude oil production revenue rose 28 per cent. Operations of Trans-Tex Drilling Company and Gate City Steel Works, Inc., both new acquisitions of Husky, were also factors in 1954 gains.

Capital Investment Steady

The trend of capital expenditures could not be put into figures as only a few reported them for the 9 months but they seemed to be keeping up well with last year and will probably end up with the all-time record.

The consolidated companies reported by Standard Oil Company (New Jersey) made capital expenditures of $435 million in 9 months of 1954 compared to $411 million in the 1953 period. Tide Water Associated reported capital expenditures for three quarters in 1954 at $41 million compared to $32 million in 1953.

Fast tax write-offs granted by federal authority has been a strong incentive for capital expenditures although this will level off with the new tax law which speeds up regular depreciation allowance.

Income Up Slightly

The overall picture is one that may be surprising to those who have followed the course of the industry for three-fourths of 1954. Despite oversupply, excessive refinery runs, and unexpected leveling of demand, gross income has risen about 2 per cent over 1953, the previous record, and net income for the list under study went up 1 per cent.

Interesting also is the fact that from December 1953 to September 1954 the common stock of every company of the 58 in the list showed some rise; a few were slight, the majority substantial, and some were spectacular increases.

This unbroken trend is due to the general stock market buoyancy, to expanded capital investment in recent years, and to increased dividends.

As the petroleum industry earnings level off any attempt to use the combined figures to point up particular factors is impossible. Of the large integrated companies some showed decreases from 1953 and others had gains. Producing companies were divided similarily. Each company report has to be examined separately; the overall picture is an industry moving on a fairly level line, with individual firms having a wide range of income increases or decreases.

In spite of record income, percentage returns on investment will likely be less this year than in 1953. This rate of return on net capital has been decreasing since 1951 when returns were 16.8 per cent; 1952 showed 14.6 and 1953 had 14.5 per cent return. Net investment has recently been estimated at $18 billion.

What's Coming?

When all the figures have been added and averaged and analyzed, the economist is supposed to have a good idea of what the future holds. The trouble with that simple step is that there is no way of determining in advance what people will do.

Last year the economists predicted a 4 per cent rise, or thereabout, in 1954, and it looked right on a curve but the public never filled its consuming role. People had more money but spent less; business was forced to reduce inventories, and production slowed.

Countries in the free world outside the U.S. have had a more rapid rise in oil consumption and probably will continue to in 1955. In Western Europe, for instance, 1954 consumption is running 8 to 10 per cent higher than in 1953. Australian consumption for the first half of 1954 was 12 per cent above the 1953 demand for oil products.

This year the predicted increase for oil and gas in 1955 has been slightly lowered, perhaps because of dampened spirits within the industry. The 3 per cent increase generally mentioned seems a safe estimate since recent weeks have shown business and industry on the rise.

So far no one has openly predicted any slowing down for business in 1955, as every one was freely doing a year ago. The question of the future has been concerned only with the rate of speed of expansion.

These factors will have the most effect on petroleum's economic fate: Excessive producing and refining capacity, oil imports, and federal regulation of gas production. Because the industry is giving more than usual attention and more concentrated effort to working out its problems brings real hope for improvement.

In this event, the petroleum industry can look forward to its greatest year in 1955. * * *

*November 15, 1954 issue, Page 11.

XUM

IN A SURPRISE ATTACK

WILL *YOU* SURVIVE?

Preparedness is our first line of defense, for an enemy is not likely to strike a nation geared to strike back. Ordinary caution, which stems from the instinct of self-preservation, can only keep us half safe. In order to be sufficiently secure so that most of us may survive an all-out enemy attack, planned security is essential.

Frank V. Martinek, assistant vice president, Standard Oil Company of Indiana, and one of the nation's foremost authorities on plant security and protection, was questioned about the part of the petroleum industry in this preparedness program. He gives here some practical answers to what can be done about security now.

Question: Why should the petroleum industry be so interested in civil defense?

Answer: Petroleum is one of the most vital products that a nation has in wartime, and will be among the first that an enemy would seek to destroy. If the industry is prepared so that damage inflicted is at a minimum, the flow of products for defense cannot be seriously impaired. The role of the industry is twofold: It must keep oil products flowing and it must, along with every other loyal American, protect its country's interests against all emergencies.

Q. Does your own company have a security program?

A. Yes. Standard of Indiana began several years ago to study the idea of setting up a protection and security program that would give us the protection we need at the present and be ready to shift into high gear in case of emergency. While we hope that an attack never comes, prudence dictates that we take some precautions. The principal steps taken have not been unduly expensive, and some have had collateral advantages. They include:

1. *Microfilming and remote storing of all important corporate records.*
2. *Renting empty warehouse space outside Chicago for possible emergency offices.*
3. *Setting up detailed plans for emergency office staffing and operations.*

Other actions taken by our company mainly for operational reasons also tend to promote our preparedness against possible atomic attack. One new refinery has been built in a relatively nonstrategic area. Our products pipe lines, which have been extended to interconnect four of our inland refineries and their main markets, would help to prevent possible disruption of our supply system. Also supervisory activities in all branches are being more and more decentralized.

Q. Will it cost a lot of money?

A. There is no need at this time to spend a lot. Preliminary planning is adequate. As I have said, our company's security program has not been prohibitively expensive, and we feel that we have gained advantages by having it. The actual cost is impossible to estimate in dollars and cents. Essentially the same program can be put into effect by all companies, but individual organizations will have their particular problems. The cost is infinitesimal to the price we must pay if we fail in our duty to our country and ourselves.

Q. Is there any hurry about getting such a program started?

A. Yes. The time is now. We are vulnerable to attack. We must prepare against attack whether it comes or not. No one wants war. We all hope for everlasting peace. But so long as the basic ingredients of conflict, selfishness, and greed rule the minds of some men, we must be prepared. We should not fear communism, but rather we should develop confidence in our traditional way of life and enlarge our faith that we can turn back the tides of the Dark Ages. Confidence can only be restored by the knowledge that we are prepared and only faith in ourselves, accompanied with appropriate action, will sustain the peace we hope for. A planned security program will give us this confidence.

Q. What do you mean by a planned security program?

A. I mean that each plant should be organized for its own protection and be prepared to cope with every problem that might arise on the basis of experience. First, the program should be thought out and blueprinted by company executives. Then it should be

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put into sufficient practice so that each individual knows his role. Only by doing this can we act with experience in an emergency.

Q. Do you see any immediate danger?

A. No, but many persons living today owe their lives to planned security methods, so planning can help us in peace as well as disaster. Every day safety habits developed now are a first step toward industrial security in the event of a national emergency. We are more vulnerable to attack with modern weapons that were London, Berlin, Cologne, and many other cities during the last world war. A single blast on an American city could cause hundreds of thousands of casualties and the survival of many thousands of people living today depends upon the extent to which they are prepared to withstand the terrible shocks and effects of modern weapons.

Most of us have no idea what we would do in an emergency. We have relied upon the police, fire department, public services—the other fellow—to help in distress. The danger of sudden disaster seems remote. But we must remember that it also seemed remote to the people of Rotterdam and Warsaw until the bombs fell. The same international tensions exist today as they did just before the attacks on those cities. We should be forewarned because we know that our country and our cities are potential targets of the enemies of the free world.

The United States has never been thoroughly prepared against attacks without warning, but history has taught us a costly lesson and we should remember it. We are now in the tenth year of the Atomic Age, and our potential enemies have greater powers of destruction than ever before. This must be met with more intensive safety plans in our country.

Q. Isn't it possible that we'll be going to a lot of trouble and expense for nothing?

A. We hope we are! We hope we will never need this program, but it is good business, even in time of peace to have adequate security methods against fire and sabotage. We must stay awake and remain alert no matter who else is taking communist peace pills. Planned protection is always good business which pays dividends in peace or war. Make no mistake that espionage agents are among us. They have infiltrated most of our industries with the avowed purpose of sabotaging our productive power. An accumulation of separately minor acts of sabotage could collectively assume the proportions of bomb damage. We must recognize the danger. Then do something about it. I prefer to call civil defense, self defense. The danger is real and ever present, but interest rises and falls according to good or bad news reports. We must not permit optimistic and conflicting reports to deter us from our purpose.

Q. Who should be responsible for organization of this security program?

A. We need high level leadership that accurately judges the danger and frankly advises us how serious the threat is to our existence. Until an authoritative agency assumes this responsibility on a national basis, we must prepare our defenses on a local level. The National Petroleum Council has asked the Interior Department to set up emergency committees to direct operations of the oil and gas industry in case of atomic attack. It also suggested that the government figure out a way of putting this entire emergency program into action by a presidential proclamation. Until such a plan is put into effect, we must do our best by individual and collective effort to assure self-preservation and continued operation of our industrial facilities. The primary responsibility rests upon plant owners and operators to organize their own protection and security agencies.

Q. How should plant protection be organized?

A. A Committee on Plant Protection and Security should be set up in each plant. Its primary duties would be:

1. To take immediate steps for protection and security of all facilities and personnel and coordinate all plans for action into a pattern for civil defense.

2. To draw up definite plans to become effective only upon declaration of war, to cover special measures and techniques to carry out defense against destructive forces of an atom bomb, bacteriological warfare, sabotage, espionage, and subversive activities.

This committee should be headed by a plant protection officer who is an executive; preferably one experienced in the field of law enforcement, safety, protection, and security. Since he will direct the entire plant safety program, he must have the respect and cooperation of management and employees.

The plant protection officer would function in two capacities:

1. He would establish a clearing house for gathering, classifying, collating, and evaluating information from all sources within and outside the company. In this clearing house would be kept centralized files of all information.

2. He and members of his staff would maintain liaison and cooperative contact with the Army, Air Force,

AUTHORITY ON PREPAREDNESS

F. V. Martinek examines a cigar incendiary bomb and fountain pen with time bomb.

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Author of the newspaper adventure strip, "Don Winslow of the Navy," Martinek accurately and in detail predicted the Japanese attack on Pearl Harbor. He is a former Fleet Intelligence Officer of the Navy's Asiatic Fleet, World War I.

Martinek began his career as a copy boy on a newspaper. He once set up a scientific crime detection school in Chicago and was recognized as one of the country's best fingerprint experts. He was a special agent of the Department of Justice from 1921 to 1925. He is author of the book, "Know Your Man," on the selection and placement of employees, and he is a widely known speaker and lecturer.

"We must remain alert no matter who else is taking communist peace pills"

Naval and AEC Intelligence units, FBI, municipal, state, and national defense agencies, and other enforcement units in the state. In other words, this might also be known as the Plant Control Center and would be the most vital part of a plant protection system.

Q. Would others be needed outside the committee?

A. In addition to establishment of the emergency plant protection organization, volunteer groups should be trained in such activities as rescue, first aid, radiological monitoring, and other activities.

Of course, the Plant Protection Officer should be an integral part of the local Civil Defense organization. All units of the plan should be put on immediate alert for the protection and security of facilities and manpower. Each department head should be held accountable for protection and security of his respective plant and facilities. Fact information should be supplied in bulletin form, outlining problems covering plant protection and security, sabotage, espionage, and subversive activities; company magazines and trade journals should bring dramatically to the attention of employees and members of their families necessity for extreme caution and care.

The Plant Protection Officer should be prepared to bring matters pertaining to protection and security to the attention of all employees, supervisory heads, and executives.

Q. What are the specific problems that must be considered?

A. There are at least eight specific and particular realms in which this Plant Protection group should move. They are, briefly:

1. *Employee Identification:* All employees should be identified at all times with non-tamperable identification badges and cards. Only persons responsible for the free flow of production should be permitted to enter and leave the plant. Rigid check-in and check-out systems should be adopted with restriction of employees to their work areas. All employees should be fingerprinted and these prints forwarded to the FBI.
2. *Employee relations and personnel:* Both old and new employees should be investigated carefully and discreetly to give management assurance of their loyalty. New employees should be selected with utmost care and advised that they may be inconvenienced by special rules designed to protect them as well as their fellow workmen. Employees should be advised to exercise vigilance and report trespassers and suspicious actions.
3. *Proper evaluation and dissemination of information received from employees about possible subversive activities within the plant:* The central clearing house should evaluate information before it is passed on to other government departments and gossip and unfounded rumors must be eliminated because they could injure innocent people and would burden investigative units with unnecessary work.
4. *Aliens:* Particular attention should be given to the screening of aliens.
5. *Protection of plant area:* No photographs should be allowed within the plant except those authorized by management; no airplanes should be allowed to fly over facilities. Adequate fencing, lighting, screening, and flood lighting should be provided. Restricted areas should be protected. Guards, patrols, and watchmen should be carefully selected, trained, and supervised. Communication systems and transportation systems within plants should be protected at all times against possible sabotage.

   A special gate should be set aside for checking in and out of casual employees, their tools, equipment, bundles, packages, and lunch boxes. Entrance should be vigilantly guarded and unauthorized persons kept out. The outer areas of the plant should be checked periodically by prowl car.
6. *Visitors:* Visiting must be restricted. No one should be allowed in the plant except for legitimate and necessary reasons. Trucks going in and out of plants should be examined carefully because explosive and incendiary bombs could be concealed and so timed to be set off within the plant to start fires and sabotage.
7. *Administrative protection against espionage:* Classified information must be protected within the meaning of the espionage act. Keys and safe combinations should be given out with extreme care. Waste paper should be disposed of by burning or shredding. Guards, watchmen, patrolmen, janitors, and charwomen should be examined and closely watched.
8. *Safety measures:* Every effort should be made to prevent fires, protect property, and eliminate possible accidents. Fire prevention and protection, such as good housekeeping, physical barriers, and the eliminating of fire hazards, are essential. Fire alarms and water supplies should be coordinated with public fire departments, except in those instances where the plants within their own confines are protected by restricted contracts that will not permit outside agencies to enter the plants.

Q. In case of attack, what do we gain by this preparation and planning?

A. Possibly our lives. Preparation will reduce calculated casualties 80 per cent and help us survive as a production center regardless of where we are. A prepared city, plant, or other facility is a poor target because it can't be hurt badly enough to make it worth the effort. War may come at any moment or it may not come at all. Weakness is an invitation for assault from a predatory nation. By the same reasoning, strength is a deterrent and, through preparation, assaults upon our cities may be averted. What we do now and in coming months may determine our future as a nation.

Q. With Russia talking of peaceful coexistence, isn't danger lessened?

A. Bishop Sheen summed it all up when he made the statement: "The more Russia talks of peace, the graver is the danger of another Pearl Harbor." The Soviet aim is world revolution and communist control of all resources and governments. Its method is to create dissention, strife, and chaos by exploiting differences—pit one group against another—then take control when each side has played itself out. The technique is use of the lie, cunning, theft, sabotage, and subversion.

World conquest has long been decreed as the ultimate goal of communism and communists have never deviated from the long range plans first declared by Karl Marx and supplemented by Lenin, Stalin, and Malinkov. We are committed to a policy of containment and the pressures within the iron curtain are great. Korea and Indo China are examples of pressure leaks that might break out in other parts of the world.

The situation is tense for we know that the people behind the iron curtain have been warring nations since the days of Genghis Khan. Only the productivity and the might of this country remain an obstacle to the fulfillment of communist aims. Our industries are the road block that must be destroyed to open the highway to universal communism.

It is our business to see that they are not destroyed. * * *

P 923.41

The ABC's of Oil Payments

Here is a practical plan for financing oil and gas properties, liquidating loans on them, figuring best tax treatment for seller and buyer

HAROLD HARLAN HAMMER

As long as individuals may have tax rates as high as 91 per cent and corporations up to 52 per cent, for ordinary income, and capital gains are subject to a maximum levy of 25 per cent, there is no mystery about the increasing interest on the part of taxpayers who are willing to dispose of their holdings if they can so shape the transaction as to benefit from the capital gains provisions in the federal tax laws. More often than not, however, the purchaser is faced with the usual problem of financing the acquisition with only a small amount of cash. These factors have led to various techniques of financing the acquisition out of the proceeds from the operation of the property itself, with resultant varying degrees of success, and the inevitable litigation instituted by the tax-gatherer.

As it is the purpose of this article to discuss some of the uses of oil payments in such financing, a few general definitions would seem to be in order. An oil payment, in effect, may be appropriately described as an over-riding royalty, limited in extent or in time, or both. Moreover, it is an "economic interest," created by grant or by exception or reservation, entitling its owner to a stated number of barrels or a specific total amount of money payable only out of a stipulated percentage of the oil (or the proceeds of the sale thereof), if, as and when produced. The owner of an oil payment, as the owner of an economic interest, is entitled to benefit from the federal income tax allowance for depletion thereon.

As the owner of an oil payment can look only to the stated percentage of the oil for the money called for by such oil payment, and as the creator of the oil payment may not in any guise insure or secure the payment of such money from any other source (and still receive favorable tax-treatment as hereinafter indicated), the oil payment does not constitute a debt of the creator.[1] While the use of oil payments and other related methods of financing the acquisition and development of oil properties is not new, for some obscure reason the courts have frequently treated oil payments as *sui generis* and have given little consideration to the fact that somewhat similar concepts have existed for many years in other branches of the law.[2]

Inasmuch as modern scientific methods have made possible the accurate estimation and evaluation of reserves and the obtaining of maximum recovery from a given property, the oil industry has established itself as a sound credit risk, and, consequently investors, bankers, and insurance companies now give favorable consideration to self-liquidating loans on oil-producing properties.[3]

Economic Interest and Property

There is a considerable lack of uniformity in the various jurisdictions as to the legal nature of an interest conveyed by an oil and gas lease. The early theory of oil-in-place, under which an actual grant of part of the realty was visualized, has been rejected by many states due to the fugacious, vagrant nature of oil and other hydrocarbon substances. Today the courts generally consider that the owner of realty has not an absolute title to oil in place but merely an exclusive right to explore, drill, and retain all oil and gas brought to the surface.

Under Texas law, the assignment, under any of three usual granting clauses, of an economic interest in oil and gas represents a present transfer of a determinable ownership-in-fee of oil and gas in place.[4] Oklahoma, on the other hand, espouses a non-ownership-in-place theory.[5] In Kentucky, the title to oil and gas in place, whether severed or unsevered, is a qualified one. Because of the fugacious characteristics of oil and gas, the landowner does not own the oil and gas in the sense that he owns the surface of solid minerals, but his ownership is limited to the exclusive right to explore and, if oil or gas should be found, to reduce these elements to possession and ownership. Until that is done, the oil and gas might escape and be captured by another through wells on other premises; but, the landowner has the right to exclude all others from attempting to exercise the right on his premises.[6]

In other jurisdictions, the lessee's interest has been variously described as: A profit-a-prendre; a corporeal hereditament; an incorporeal hereditament; an estate in land; an estate in oil and gas; a servitude; a chattel real, and personal property.[7] But regardless of the theory of ownership, in all jurisdictions the mineral rights can be conveyed separately from the surface. To further complicate (or possibly simplify) the problem, local concepts are disregarded for federal tax purposes, as hereinafter indicated.

Thus, the "property," in oil and gas parlance, does not refer to land as such but, in the language of the Bureau of Internal Revenue, to an "economic interest" in a mineral deposit in a tract or parcel of land,[8] or, according to some courts, to all economic interest in a single "mineral property."[9] More specifically, "an economic interest is possessed in every case in which the taxpayer has acquired, by investment, any interest in minerals in place" and from such interest, income is derived from the severance and sale of the minerals to which he must look for a return of his capital.[10]

Assurance of a share of production is a distinguishing characteristic of ownership of an economic interest in oil and gas in place.[11] Economic interest does not mean title to the oil in place, however, but merely the possi-

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bility of a profit from that interest dependent solely upon the extraction and sale of the oil.[12] The nature of this concept is illustrated by the early holding that all persons who have an economic interest in oil and gas in the ground have a right to share in the depletion allowance.[13]

Royalties, Reservations, and Oil Payments

It seems appropriate to discuss the four more usual types of assignments that are revealed by the extensive litigation on the subject. They are here treated in the chronological order of their development.

1. Palmer v. Bender–type assignment. Where the transferror of an oil or gas lease, instead of conveying all his interest, conveys an interest in the leasehold but reserves an overriding royalty interest, it is commonly described as a Palmer v. Bender-type of assignment.[14] This transaction is analogous to a sub-lease, and the cash received is treated as a bonus returnable as ordinary income (subject to depletion) and not as proceeds from the sale of a capital asset.

The transferror's unrecovered cost becomes his basis for the overriding royalty interest retained, amortizable via depletion charges, since the periodic proceeds from the overriding royalty, when received, are returnable as ordinary income.[15] The transferee has a capital investment in the leasehold interest acquired by him to the extent of the cash bonus paid.[16] The transferror's receipts from the overriding royalty are not constructively received by the transferee (purchaser), just as royalty receipts by the landowner are not the income of the lessee or assignee under the usual oil and gas lease.[17]

2. Fleming–type assignment. Where the transferror of an oil and gas lease does not reserve an overriding royalty (as in the Palmer v. Bender case) but instead receives part cash and retains an oil-payment, different tax treatment results. This is frequently referred to as the Fleming-type assignment.[18] The oil payment can be payable in either barrels of oil (an "in-oil" payment) or in dollars.[19] If the oil payment is for a stipulated dollar amount, another factor, the future price of oil, should be taken into consideration in weighing the relative advantages of an oil payment in dollars as against the overriding royalty-payable-in-oil method.

If oil goes up in price, the overriding royalty-payable-in-oil will be worth more than an oil payment payable in dollars and will have greater security because it will produce more dollars. An oil payment expressed in terms of dollars will, of course, never return more than its face amount.[20] The oil payment is clearly an economic interest in oil or gas regardless of how acquired.

In the Fleming case, although no overriding royalty is reserved, a sale occurs although, in fact, an oil payment is very similar to a limited overriding royalty. The cash paid by the transferee is not considered as an advance on royalty; hence, it is not treated as a receipt of ordinary income, as in the bonus cases,[21] but is treated as proceeds from the sale of property.[22] The oil payment retained in the hands of the transferror is considered as a reserved economic interest, and subsequent income therefrom is ordinary income subject to depletion.[23]

The transferror's basis is allocated between (a) the money-value of the portion of his estate sold (e.g., leasehold), which is offset by any cash received, and (b) the money-value of the portion retained (oil payment), which becomes the basis for his oil payment, to be recoverable in the future via depletion—on the basis of the respective fair market values of (a) and (b) above at the time of sale. If physical equipment was also transferred, the seller, in computing taxable gain, is entitled to a deduction of the full adjusted cost of such equipment from the cash payment on the sale.[24]

Where the seller parts with title to depreciable property, clearly the seller's basis on the equipment is allocable first to the gross cash sales-price,[25] although the commissioner argued (unsuccessfully) that the equipment costs of the seller should be allocated between the cash consideration and the value of the reserved oil payment. The more complicated problem is how much of the leasehold basis is allocable to the sales-price, and the formula applied in this connection in the Columbia Gas case, supra, seems to be fairly well settled.

3. Anderson v. Helvering–type assignment. An oil payment is a true oil payment entitling its holder to depletion only if it is payable solely out of production and is not otherwise secured (e.g., by personal guaranty, collateral, etc.). In the Anderson case,[26] the Oklahoma City Company agreed to sell its interests (which included royalty interests, fee interests, and deferred oil payments) to the taxpayer for $160,000, payable $50,000 in cash and $110,000 from one-half of the oil to be produced from the properties and from the sale of the vendee of the fee of any of the land conveyed. This reservation of an interest in the fee, in addition to the interest in the oil production, materially affected the transaction, and it was held that the part of the gross proceeds that the vendee received from production and sale of oil from the properties and paid over to the vendor pursuant to the contract should be included in the gross income of the vendee.

Although an assignment ordinarly transfers legal title to all the leasehold estate, an oil payment is merely an equitable charge or lien on the lease.[27] If the oil payment is guaranteed by the assignee, however, (there was no personal guarantee in the Anderson case, but the $110,000 was payable in part out of proceeds from the sale of the fee-title), or if the assignee promises to pay the amount in any event, irrespective of whether or not payable solely from production, then income from the entire leasehold interest is treated as taxable income to the assignee.

As noted, there may be payments in oil which are not "oil payments." When oil runs are assigned to a bank to pay off a loan, the bank is receiving its payment in oil but it does not have an "oil payment" because it does not have an economic interest in the oil in the ground. If the obligation is definite, not contingent upon production, it is a payment in oil that is not an oil payment.[28] In determining whether or not an oil payment creates an economic interest, two tests have developed in the courts; namely,

a. It must be payable solely out of production, and

b. It must at least create an enforceable contractual right to share in the production.[29]

The seller, on the sale of his property, will measure his capital gain or loss by computing the difference between his basis and the present value of the obligation calling for the payment in oil.[30] As the consideration will be payable over a period of years, if less than 30 per cent thereof was receivable

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in the first year the seller may elect to use the installment method, reporting in each year that portion of the total gain to be realized which is represented in the payment received.[31]

4. Burton-Sutton–type assignment. Where the assignor reserves a right to share in a specifiied percentage of the net profits of production and operation of the property, the result is the reservation of an economic interest in the oil—not a sale.[32] The U. S. Supreme Court makes no distinction between a net-profits-type assignment and one payable out of gross proceeds from production;[33] in fact, this reasoning has been carried over into recent legislation in connection with taxation of unrelated business income of a tax-exempt corporation.[34]

In the Burton-Sutton case, the taxpayer was actually the payor and not the receiver of the net-profit rights, but the Supreme Court, reversing both the Tax Court and the Court of Appeals and stating that the holding of these rights alone constituted an economic interest in the property, in effect overruled the Elbe case,[35] although the court did not expressly overrule. This was made clear by acquiescence in the Horton case.[36]

Thus, the assignor was permitted to treat the cash received and the net-profit payments as proceeds of sale, out of which he first allocated his depreciable and depletable bases, the balance being capital gain and not ordinary income subject to depletion. The assignee, on the other hand, was required to capitalize the cash payment; all of the income was taxable to him; and he was required to capitalize the net profit payments when and as made to the assignor.[37]

Recent Income Tax Rulings

1. I.T. 3935. In 1932 the Board of Tax Appeals held in the Nail case[38] that a gift of a carved-out oil payment, which paid out in less than six months, was not a gift of the income and that the proceeds received by the donee should not be taxed to the donor. In contemplation of the Nail case the Treasury in 1949 ruled[39] that a gift of a "short-lived carved-out oil payment" after January 24, 1949, was a gift of income rather than one of income-producing property, with the result that the income, received by the donee from oil-runs, must be reported as income by the donor.

2. I.T. 4003. In 1950, IT 4003[40] was issued stating that G.C.M. 24849,[41] with respect to sales, and I.T. 3935,[42] with respect to gifts, would apply with equal force regardless of the duration of the carved-out interest, so long as it is less than the interest out of which it is carved. Hence, it is now concluded that there is no legal or practical basis for distinguishing between "short-lived" and "long-lived" oil payments. "It is, therefore, the present position of the Bureau that the assignment of any oil payment right (not pledged for development), which extends over a period less than the life of the depletable property interest from which it is carved, is essentially the assignment of expected income from such property interest."

Attorneys and tax-consultants seem to accept the conclusions in G.C.M. 24849 and I.T. 3935 as to "short-lived" carved-out oil payments, but argue that the ruling in I.T. 4003 is arbitrary, as it treats all assignments of carved-out oil payments as anticipation of income regardless of duration. As to "long-lived" carved-out oil payments (say, for over two or three years in duration), the distinction, established by the ruling in I.T. 4003, is not accepted by them and successful resistance is contemplated.[43]

The "A-B-C" Transaction

As noted throughout the foregoing discussions, the tax treatment of the proceeds of the various types of assignments and "carved-out" oil payments is still unsettled and each of the types mentioned contains inherent pitfalls that cautious participants will seek means to avoid. By way of summary, it was shown that when leases are transferred in return for cash plus an oil payment, the transaction is in part a sale for cash and in part a reservation of an economic interest.[44] The seller is treated as never having sold that portion of the oil necessary to satisfy the oil payment.[45] After first recovering the tax basis of any depreciable equipment out of the cash received, the seller's remaining basis is allocated between the interest sold and the interest retained in proportion to their respective fair market values.[46]

The reservation of an oil payment does not prevent the treatment, as a capital transaction, of any gain realized from the sale of the interest for cash.[47] Also, the Treasury Department has ruled, in general, that the sale of an oil payment right, if such constitutes the entire depletable interest of the seller, results in capital gain treatment.[48]

The combination of these factors has made popular the so-called "A-B-C" transaction, such letters being generally used by way of explanation by banks, attorneys, and insurance companies. "A," the owner of a leasehold interest, may sell his working interest rights to "C," retaining an oil payment, and then sell the retained oil payment to "B." The entire sales price of both interests in toto is treated as the proceeds from the sale of capital assets as, immediately after the time that "A" sold his oil payment, he had no other depletable economic interest in the property. "B," the holder of the oil payment, is at liberty to borrow against it. The difference between (a) the interest income to "B" on the oil payment and (b) the interest expense payable by "B" to the lender represents "B's" gain on the transaction. "C," thus, may acquire the equity for a relatively small cash outlay, and when the oil payment loan has been liquidated out of proceeds from production of the property itself, his reversionary interest has become whole and he has acquired all of the interest originally held by "A."[49]

As the share of the oil reserved under the oil payment never becomes the property of the owner of the working interest ("C"), the proceeds from the sale of the oil applied to the oil payment are never includable in the gross income of "C."[50] In other words, "C" is not chargeable with constructive receipt of oil-runs used to liquidate the oil payment to "B."

There are many variations of the A-B-C type transaction. For example, the purchase by "B" and "C" from "A" could be made in a simultaneous transaction whereby it was agreed that the sale of the oil payment would not precede or follow the sale of the operating rights but would become effective at the exact moment that both contracts became executed. Often, the seller insists that his entire interest be purchased for cash. Thus, "B" may purchase "A's" entire interest and then assign the operating rights of "C" (or vice versa), "B" retaining the oil payment. Also, an intermediary (which could be a corporation formed for this specific purpose) could purchase the

Can Oil Industry Deliver Under Attack Conditions?

Plans are being formed by the new Military Petroleum Advisory Board on oil defense problems. Development of the H-bomb, new atomic weapons, guided weapons, etc., makes urgent setting up practical defense plans. (See Page 284)

William Keeler, Phillips Petroleum Company, chairman of MPAB, says that he believes some program can be worked out within six months. It will be based on the original study made by the Petroleum Administration for Defense.

At a meeting in Washington the petroleum board was advised of some problems that could arise from an attack by the Communists. New weapons, the MPAB was told, call for a new approach and the oil industry must determine its capacity to supply defense products in various areas under attack conditions.

seller's interest and take the place of "A" in the transaction.[51]

"A" cannot be said to have a tax-avoidance motive as he relinquished the right to receive the income from the property, which he would have received had he retained the property. However, should "A" give away or anticipate future income, tax avoidance motives may be imputed to him and the Bureau has made rulings which in such a case would prevent him from shifting the incidence of tax on the theory that it was a gift[52] or from realizing capital gain based upon the theory of anticipation of expected income.[53] In the Horst case, the court said that "the power to dispose of income is the equivalent of ownership of it, and the exercise of that power to procure the payment of that income to another is the enjoyment and hence the realization of the income by him who exercises it."

As essential elements of the "A-B-C" transaction described occur simultaneously, it cannot be argued that the sale of the oil payment will occur prior to the sale of the leasehold or that any part of "A's" property will be retained by him. Thus, "A" should not be subject to attack under G.C.M. 24849, even though he has converted his expected future income (computed on the basis of its present worth) into capital gain.[54] The holder of the oil payment, "B," is the owner of an economic interest and is permitted to recover his purchase price through cost-or-percentage depletion. "C's" complete absence of identity with "B" will be emphasized by the fact that "B" makes a profit on the transaction, either by a differential (a) in the interest rate between that earned on the oil payment and that paid to the money lender, or (b) between the amount of the oil payment and the principal amount of the loan.

One institution computed the actual tax savings in a hypothetical sale involving a cash payment of $1,200,000 plus an oil payment of $3,500,000 with interest at 5½ per cent, payable out of 70 per cent of the production, by showing that when the oil payment is simultaneously sold to a third party ("B"), the latter is able, in the hypothetical case, to borrow the full amount of the oil payment at 4½ per cent, thus keeping "B's" separate identity clear and permitting him to have a profit measured by the difference in interest rates, namely 1 per cent, and the purchaser ("C") retains 30 per cent of the oil-runs out of which he pays operating, development costs, and income taxes. Thus, if the property were purchased under these terms, it would be worth 20 per cent more than if purchased for cash or financed by a direct loan and the transaction would result in a tax-saving of $800,000.[55]

How ABC Plan Works

The "A-B-C" plan, as described appears to offer one of the more effective solutions to the varied problems facing buyers and sellers of oil and gas properties. Some of the more obvious results of the plan are as follows:

1. **The seller, "A," divests himself of all right, title, and interest in the asset and, for tax purposes, effectuates a capital gain on the sale.**
2. **The bank-loan, if any, obtained by the holder "B" of the oil payment will normally be completely liquidated by oil-runs from the property.**
3. **As the oil-runs to "B" are applied against the bank-loan, "B's" interest is eventually extinguished.**
4. **The purchaser "C" is not chargeable, for income tax purposes, with constructive receipt of the monies or oil passing directly to "B."**
5. **Through this means of diverting income from the property to pay off the bank-loan and the oil-payment, "C" has acquired the seller's interest at a minimal out-of-pocket cost.**
6. **After liquidation of oil payment, "C's" interest is complete and unencumbered, and he receives 100 per cent of income, subject to depletion.**
7. **Thus, "C" is in position to realize a long-term capital gain, measured against his low-cost basis (and, like "A," may then effectuate another "A-B-C" type transaction, if he so desires).**

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Exploration, Drilling, Producing

Shell Expands

Shell Development Company, research affiliate of Shell Oil, will expand its Emeryville, California, laboratory and office facilities by 50 per cent through the purchase of Western Electric and Pacific Telephone and Telegraph properties. Shell Development has signed an agreement to buy 3 buildings and 4.3 acres of land adjoining its present site. The deal has been approved by the California Public Utilities Commission. The new addition is Shell Development's fifth major expansion program since it was formed in 1928.

★ ★ ★

Alaskan Option

LeRoy H. Hines, San Francisco petroleum consultant, has announced that a group of persons represented by him has entered into option agreements with Union Oil Company and Ohio Oil Company covering 55,000 acres of oil leases on the Kenai Peninsula, Alaska. The acreage is in the immediate vicinity of the area where Standard Oil Company of California recently leased 750,000 acres from the federal government.

★ ★ ★

New IOCC Building

A new modern office building to house the Interstate Oil Compact Commission in Oklahoma City, has been completed amid the gas and oil wells that dot the state capitol grounds. At the dedication ceremonies, Johnston Murray, Governor of Oklahoma, presented the keys to the building to Earl Foster, executive secretary of the Commission.

The Commission is a combination of 28 states, bound by treaty to stimulate the petroleum industry through state conservation programs designed to develop the use of gas and oil and maintain a continuous supply. The Commission itself has no power to regulate any phase of the industry other than the presentation of effective ideas to educate member states and their industry. Regulation of the industry is reserved by individual state legislation and administered through local state agencies.

Construction costs for the new building were appropriated by the Oklahoma state legislature as a gift to the Commission from the reserve built up in the conservation fund.

California Royalties

The Interior Department turned over to the State of California a check for $22,041,994.66, representing royalties collected by the state for oil and gas leases in the 3-mile marginal belt off the coast of California for the period 1950 to May 22, 1953, when Congress passed the quitclaim law.

★ ★ ★

Research Expands

Construction of more than $1,500,000 in new facilities are being undertaken at the Richmond, California, laboratories of California Research Corporation. The expansion program is designed to modernize existing facilities and provide for anticipated future growth of the Standard Oil Company of California subsidiary. Involved in the program will be erection of a new engine laboratory and a new wing on the main laboratory-administration building.

★ ★ ★

Offshore Test Set

Texas Company has awarded to Kerr-McGee Driling Company a contract to drill Texaco's first Texas tidelands test well approximately three miles offshore from High Island, Galveston County. Drilling will be started shortly after December 15.

The "Kermac 44," a modern submersible drilling barge, will be moved on the location to operate in 29 ft of water to drill to a projected depth of 9000 ft.

★ ★ ★

Arabian Production Up

Crude oil production in Saudi Arabia during September increased to 28,256,361 bbl, or an average of 941,877 bbl per calendar day. This is a jump of 12½ per cent over the same period of 1953.

Crude processed at Ras Tanura averaged 231,005 bbl per calendar day for the month.

★ ★ ★

Oil Merger Planned

Howard Pyle, president, Monterey Oil Company, Los Angeles, California, has disclosed plans for his company to merge with the Fullerton Oil Company.

Aluminum Derrick

Franks Manufacturing Company of Tulsa, Oklahoma, and Reynolds Metal Company, of Louisville, Kentucky, have announced the perfection of an aluminum derrick. Elimination of 50 per cent of the weight of the same size steel structure is the prime advantage of the 100-ft telescoping type derrick.

Although the aluminum derrick costs more than steel, manufacturers claim savings effected by reduction of weight, adding to highway capacity, makes it competitive. Derrick telescopes and folds over the vehicle for moving over highways from one well location to another. It is built with square aluminum tubing legs and bracings for strength and stability.

★ ★ ★

Offshore Drilling Banned

Plans for offshore drilling in Santa Monica Bay area were killed when citizens of Santa Monica, by a vote of approximately three to one, rejected a proposal which would have modified a municipal ban on oil drilling within the city's corporate limits which extend into the bay.

★ ★ ★

Offshore Rig Commissioned

Glasscock Drilling Company's new 3½ million dollar mobile platform has been commissioned at the Beaumont yards of Bethlehem Steel. Designed to operate in 100 ft of water, the new rig will go into service for Shell about 8 miles east of San Louis Pass off Galveston Island, Texas Gulf Coast.

★ ★ ★

Cities Service Adds Annex

Construction of a five-story annex to the present Cities Service building in Bartlesville, Oklahoma, will begin in the first week of November with completion set for the middle of 1955. In addition to having a full basement, plans call for a reinforced foundation which will permit the addition of five stories atop the proposed structure, should the need for future expansion arise. The buildings will join at each floor level.

The modern design of the proposed reinforced concrete building will blend into the existing structure and will be carried out across the entire first floor front of the two buildings.

XUM

The BAKER RETAINER PRODUCTION PACKER.

What is a Permanent-Type Well Completion?

HERE ARE THE FACTS:

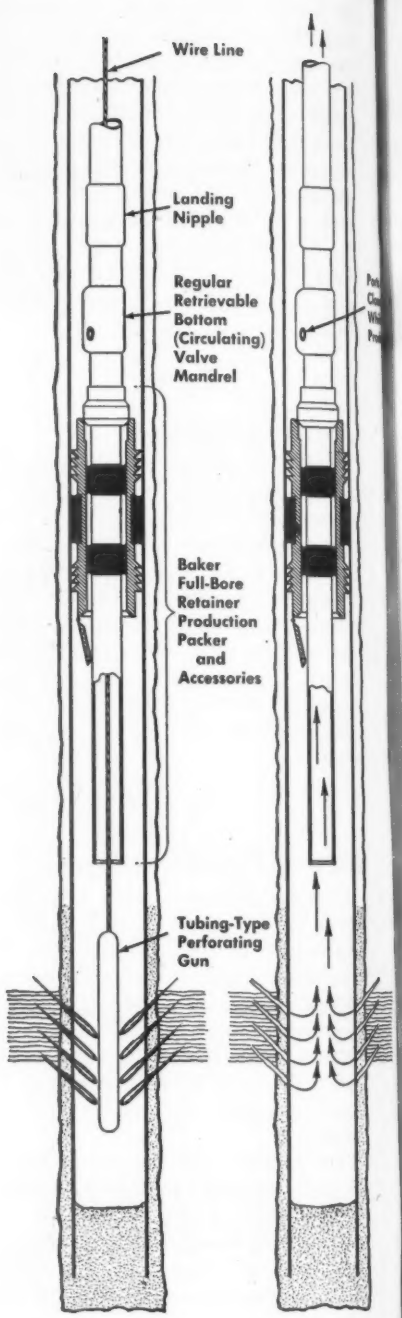
A Permanent-Type Well Completion is generally considered to be an installation providing for completion, production, repair or recompletion in other zones without requiring a drilling or work-over rig.

All tools are run *through the tubing string* after it is landed and nippled up.

If the completion is successful, the tubing need never again be moved until all zones of the selected interval have been exhausted.

Advantages Claimed for Permanent-Type Well Completions

1. **SAVES AT LEAST ONE TO TWO DAYS RIG TIME during the original completion.**
2. **ELIMINATES COST OF SEPARATE TESTING AND SQUEEZE TOOLS.**
3. **REDUCES WORK-OVER COST AS MUCH AS 75%, by eliminating work-over rig, cost of mud, time and equipment to kill well. Reduces loss of production through saving in work-over time.**
4. **PERMITS THE ECONOMICAL TESTING OF THIN OR QUESTIONABLE SECTIONS.**
5. **PERMITS USE OF WATER INSTEAD OF MUD while perforating completing, or re-completing. This practice reduces formation contamination and may result in an increase in the productivity of the zone.**
6. **PERMITS A MORE ACCURATE ANALYSIS OF RESERVOIR POTENTIAL.**
7. **KEEPS WELL UNDER CONTROL AT ALL TIMES.**



Where PACKERS are required . . . specify a . . .

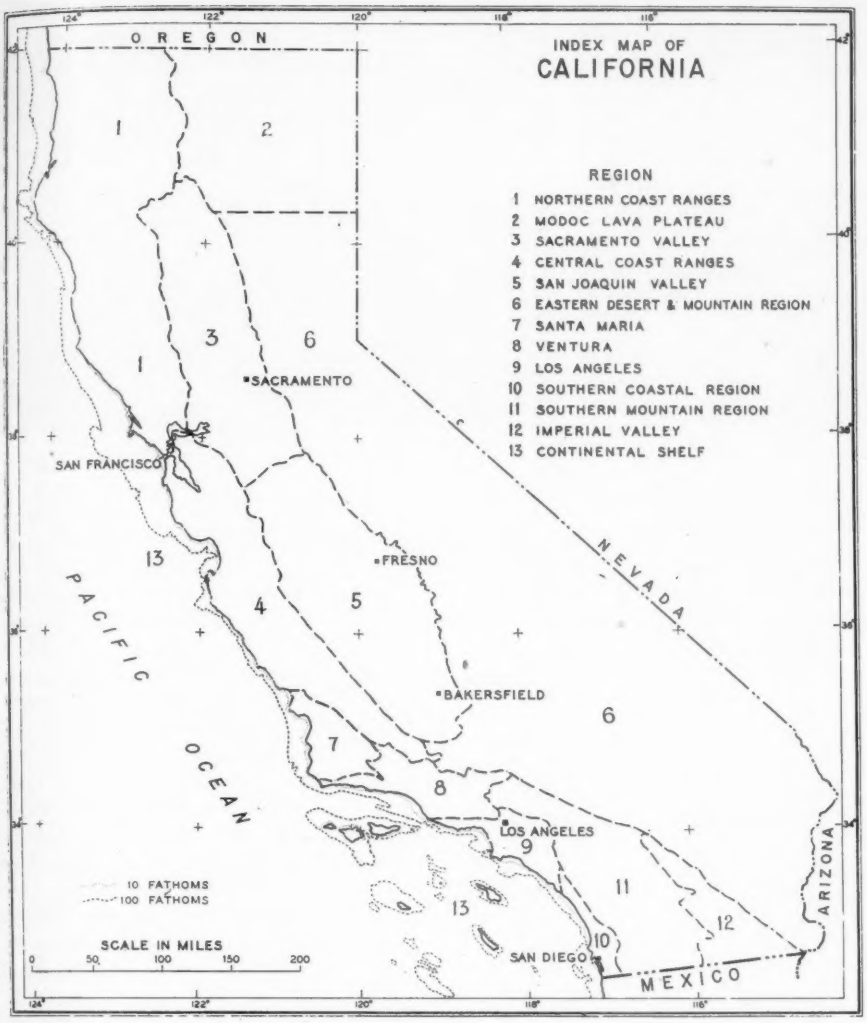


FIG. 1.

California Oil . . .

It's Geological Relation and Productive History

GRAHAM B. MOODY

GEOLOGY of California is a fascinating subject from both academic and economic viewpoints. It seems probable that the majority of *The Petroleum Engineer's* readers are interested primarily in geology as related to the occurrence of oil. Previously published books and articles by eminently qualified geologists have covered the geology of California so comprehensively that it would be a presumption on the part of this writer to do more than comment on the broader phases of geology that account for California's outstanding contribution to the nation's supply of petroleum.

Five Productive Provinces Appear

It has been customary to divide the state into the San Joaquin Valley, the Los Angeles Basin, the Ventura Basin, and the Santa Maria Basin oil producing provinces and the Sacramento Valley which is a gas-producing province. Each of these regions actually embraces several geological provinces which show great variation in their geological history and their accumulations of petroleum.

Fig. 1, prepared by a committee of the Pacific Section of the American Association of Petroleum Geologists in 1950 as a part of a national review of possible future petroleum provinces,[1] shows the various producing and possible future producing provinces of the state. The boundary lines of provinces are somewhat arbitrary and, as mentioned above, there are provinces within provinces.

Recent Movements Influence Structure

California is young and is still growing — geologically speaking. Uplift, folding, and faulting in post-Pliocene time have played a most important part in the geological structure and the physiography of this state. Ralph Reed[2] said: "Along the Pacific Coast the Pleistocene seems to have been an epoch of greater diastrophic changes than any other that has occurred since Middle Mesozoic." These comparatively recent diastrophic changes have influenced to a great extent the accumulation of large quantities of petroleum.

Another outstanding geological feature is the unusual thickness of the productive section at places. This results in some astonishing per-acre recoveries. Long Beach oil field, for example, has produced more than 500,000 bbl per acre and is a long way from extinction now. Approximate thicknesses of producing columns in a few fields read like this:

CHART 1.

Coalinga Nose Eocene..	375	Long Beach.....	1650
Ventura Avenue.....	5300	Montebello.....	1150
Newhall-Potrero.....	1350	Richfield.....	750
Shiells Canyon.....	650	Rosecrans.....	1040
Domingues.....	1000	Santa Fe Springs..	2500

Many Zones Produce

Production is obtained from zones in Pleistocene, Pliocene, Miocene, Oligocene, Eocene, Cretaceous, and Basement rocks. The petroleum found in the Pleistocene and Basement is not considered to be indigenous to those formations; it migrated into them from formations ranging in age from Pliocene through Cretaceous. The potentially productive section embracing the Pleistocene through Jurassic (?) epochs may be appreciated by a study of Chart 1 in which are shown the approximate stratigraphic thicknesses, in feet, measured at numerous localities in the various regions. The number at the head of each column gives the

[1]References are listed at end of article.

EXCLUSIVE

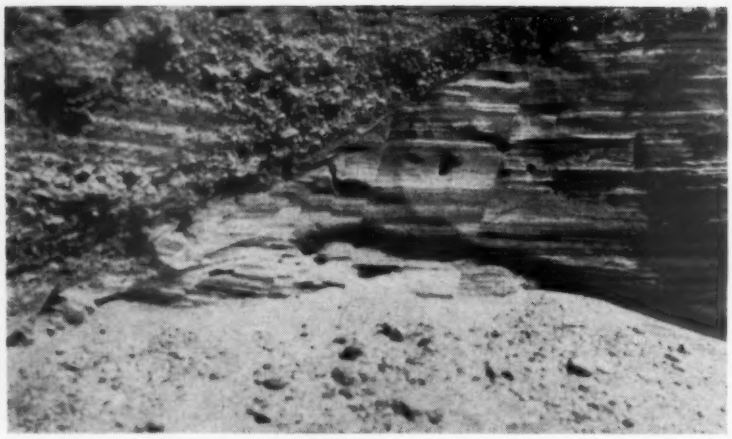


FIG. 2.

FIG. 3.

source of the measurement as listed at the end of this article.

It will be noted that the Point Conception and Ventura River sections are not taken directly from wells; hence, the total thicknesses shown are not to be expected at any one location.

The following tabulation lists by regions the epochs in which productive formations have been found.

San Joaquin Valley: Pleistocene, Pliocene, Miocene, Oligocene, Eocene, Upper Cretaceous, and Jurassic (?).

Los Angeles Basin: Pliocene, Miocene, and Jurassic (?).

Ventura Basin: Plio-Pleistocene, Pliocene, Miocene, Oligocene, Eocene, and Upper Cretaceous.

Santa Maria Basin: Pliocene, Miocene, and Jurassic (?).

Central Coast Ranges: Pliocene, Miocene, Oligocene, and Eocene.

Sacramento Valley: Eocene and Cretaceous (gas).

Geological Age Influences Productive Characteristics

The characteristics of petroleum reservoirs that occur in the different epochs vary greatly. The following tabulation shows, as percentage of state's total, estimated ultimate recovery and reserves and cumulative production and 1954 production allocated to the different epochs. Production for 1954 is partly estimated.

Origin of Production.

	Per cent of State Total			
Epoch from which the oil is produced	Estimated ultimate recovery	Cumulative production 12/31/54	Estimated reserves 12/31/54	1954 Production
Pleistocene.....	0.15	0.15	0.16	0.21
Pliocene.....	46.3	47.8	43.2	39.7
Miocene.....	47.6	47.0	48.8	49.9
Oligocene.....	1.7	1.2	2.8	3.3
Eocene.....	3.9	3.5	4.7	6.2
Cretaceous.....	0.02	0.025	0.003	0.006
Pre-Cretaceous...	0.3	0.3	0.4	0.6

These percentage figures are only approximations. Reservoirs in the Cretaceous have not yielded much oil and are not generally considered to be attractive exploratory objectives. Eocene reservoirs had a similar reputation until the Coalinga Nose field was found. Perhaps the Cretaceous will yield a substantial field some day.

Faulting Important In Trap Formation

Faulting has played a major role in shaping the structure of the state and in controlling the accumulation of petroleum. California geologists are reputed to be "fault-finding," but they earn this designation only because the faults are so numerous and so dominant and cannot be ignored. Displacements along these faults may be measured in inches, in tens of feet, in hundreds of feet, or in tens of miles. Fig. 2 pictures miniature faulting in Pleistocene sands near Inglewood; the faults in these sands are measured in inches. Fig. 3 is a clear example of faulting measurable in tens of feet within Miocene rocks near Laguna Beach.

The displacement on the fault in Fig. 4 was not measured with any accuracy but was estimated to be at least two hundred feet; it is on the south coast of Santa Rosa Island and involves rocks of Eocene and possibly Cretaceous age. These are pigmy faults, however, when compared with those of grand magnitude; for example, the San Andreas on which the unit of measurement of horizontal displacement is tens of miles.

Many of California's faults are still active. Everybody recalls the 1906 earthquake which was caused by displacement along the San Andreas rift and was accompanied by maximum horizontal movement of about 22 ft

FIG. 4.

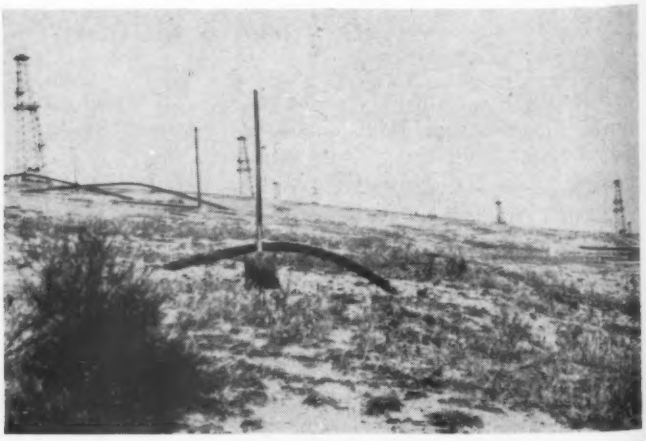


FIG. 5.

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The Author

Graham B. Moody is a veteran field geologist whose assignments with the Standard Oil Company of California have taken him to the Philippines, Mexico, and a portion of the Southwestern United States. He retired December 1 and now is engaged as a petroleum consultant. He served as chief reserves enginer on Standard's executive staff.

Moody, who completed his 34th year with Standard of California in 1954, was graduated from the University of California. In 1917 he joined the Southern Pacific Company as resident geologist. The following year he moved to the California Petroleum Corporation and was associated with that firm until 1920.

Active in petroleum industry professional circles, Moody is affiliated with the following organizations: American Association of Petroleum Geologists; American Petroleum Institute; American Gas Association; Seismological Society of America; and Petroleum Production Pioneers.

and maximum vertical movement of about 2 ft on that rift; this was surficial displacement, which, in lesser amounts, was observable for more than 200 miles along the rift.

The San Andreas rift may be considered the dominant structural feature of California but there are several others on which total displacement amounts to several miles and which still are prone to exhilirate us with occasional slips.

Operators in Wilmington are well aware of the damage that can be done to producing wells by recent earthquakes.

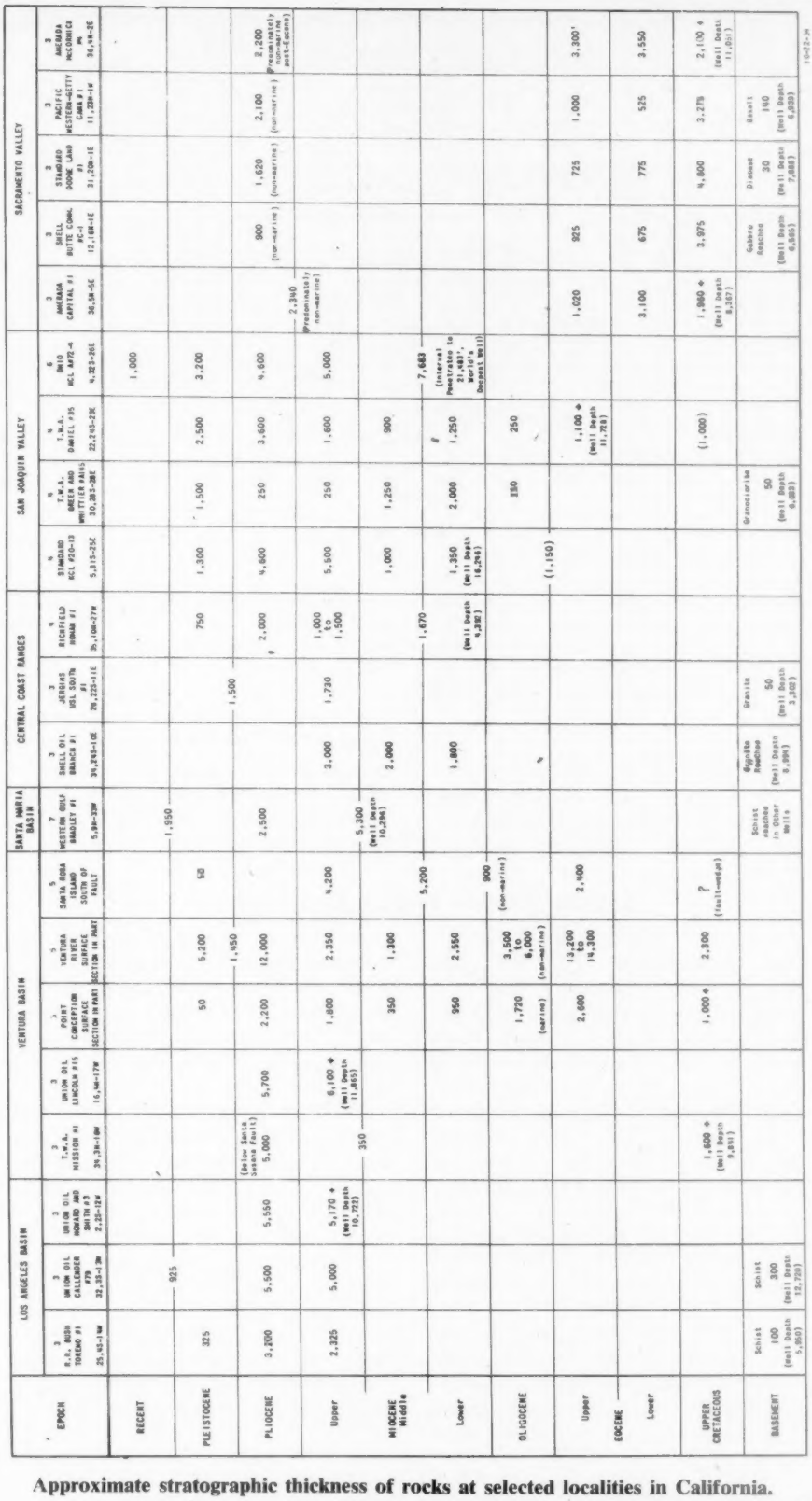
The bowing of small service lines by the shallow Buena Vista thrust fault is shown in Fig. 5. Movement on this fault, fortunately, did not damage the wells.

Overthrusting Provides Key For Future Discoveries

Normal faults in many places serve as barriers that impound petroleum in economically attractive accumulations. Overthrust faults, however, may prove ultimately to be of greater importance from the standpoint of recoverable petroleum.

These overthrusts are intriguing when considered as structural phenomena but make the interpretation of subsurface structure a really tough job. Aliso Canyon is a good example; Miocene rocks are exposed on the surface; the initial well produced no oil from the Miocene but was drilled ahead through an overthrust fault and discovered oil in the Pliocene. Subsequent drilling located other overthrusts that had jumbled the formations almost beyond belief.

Such overthrusts may cause repetition of the pay zones, thus increasing the total thickness of pay available to a well, or, conversely, may delete a pay zone from the section. Ventura Avenue is a remarkable example of duplication of pay zones. The subsurface map of this field is most intricate and must have caused nervous breakdown of the artists who drew it. The author, to reminisce a bit, advocated many years ago that subsurface geologists should spend all their spare time working the most complicated jigsaw puzzles obtainable so that they



Approximate stratographic thickness of rocks at selected localities in California.

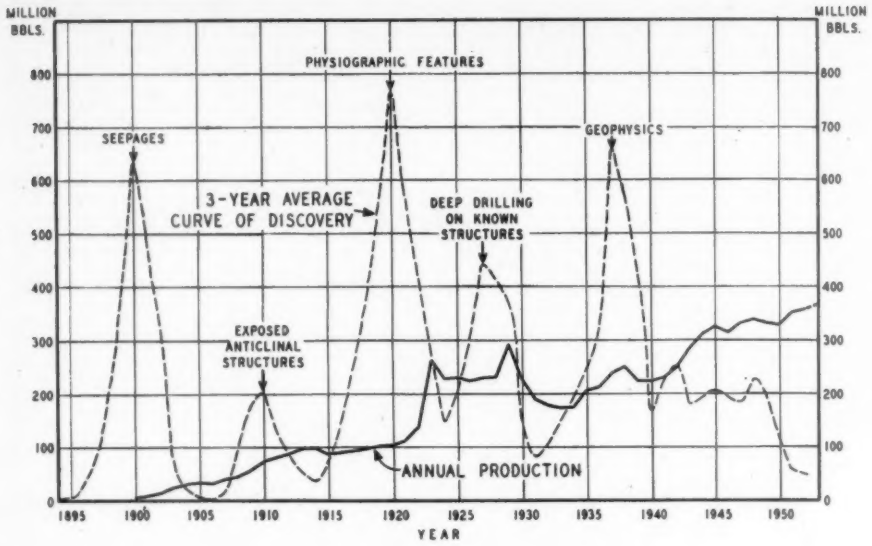


FIG. 6.

would be better qualified to interpret subsurface structure in California fields. Examinations of some subsurface maps in recent months indicates that this suggestion may have been adopted.

Most Other Trap Forms Present

Petroleum occurs in appreciable quantities in a variety of traps in California — domes, anticlines, terraces, faulted structures, stratigraphic traps, and lithologic traps. Salt domes and reefs are noticeably absent here, but we have done fairly well without them.

The correlation of petroleum occurrence with geology has been summarized in the preceding paragraphs. It is appropriate to sketch the results that have been attained through application of our geological know-how to the task of finding petroleum.

Search for Oil Began Early But . . .

The earliest explorers in California noted the occurrence of tar and commented that this substance was used by the Indians for caulking their boats and for other purposes. Some form of petroleum was being utilized here long before the first effort was made to develop systematically the oil resources of the State. An interesting observation[8] on the importance of bitumen written in the middle of the 19th century follows.

> "Bitumen is par excellence the mineral of southern California, being found in almost every county south of San Francisco."

Drilling for oil commenced in the early 1860's.[9] It is probable that geological thinking had little influence in guiding the search for oil until about 1900 despite the fact that many competent, even famous, geologists contributed during the second half of the 19th century to knowledge of geology in California. Proximity to a seepage of oil or bitumen was the major criterion in selecting a location for drilling in the early days.

Experience soon taught these pioneering explorationists that better production was obtainable if they drilled not too close to the seepage. This period of seepage-drilling reached its peak of oil-discovery in 1900.

Geologists recognized long before the close of the seepage-drilling era the importance of anticlinal structure as a suitable trap for petroleum. The industry did not admit at an equally early date the dominant role that geologists could play in finding oil.

. . . Trained Geologists Were Slow to Appear

Records indicate that the larger companies were slow to avail themselves of geological talent. One such company employed one geologist from 1898 through 1911 and, perhaps because this one was overworked, added a second in 1912; this duet carried on through 1920.

Another company acquired its first geologist in 1908 and a third company operated with one-half a geologist from 1900 through 1920. A quotation from a 1907 letter written by an executive of a large company to the president of that company indicates the then-current idea of the value of geological assistance in searching for oil.

> "As I advised yesterday . . . I believe . . . that there are possibilities and even probabilities of fields between Fort Tejon Canon and Sunset.
>
> "I feel that if the study of formation is the intelligent course to pursue in the search of oil, that the study should be thorough in every detail. . . . I feel convinced that an engineer with some idea of rocks, and his knowledge need not be extensive, the ability to discern between igneous, sedimentary, and altered rocks being sufficient, could do much toward producing the results desired. I do not claim that the application of scientific principles to surface structure will develop oil, but I do claim that careful study by means suggested will reduce the percentage of failure and consequently increase the percentage of success . . .
>
> "It occurs to me that a competent man could be employed for months in the way I mention and further, could indicate where the possibilities for developing oil were the best."

The essential qualifications of the "engineer" as well as the thought that one "competent" man could be employed for months in the northern San Joaquin Valley are interesting.

Roy Barnes[10] in 1940 found that 17 leading companies had in their employ 42 geologists in 1920. The writer attempted in 1949 to secure comparable figures for the years 1900 through 1919 but was only partly successful. Results of this investigation indicated, however, that there were fewer than 10 geologists employed on the average for the years 1900 through 1910 and not more than 20 on the average during the period 1911 through 1919. These figures will be referred to later in connection with the rate of discovery.

These pioneering oil geologists were extremely efficient. They rapidly located the exposed anticlinal structures. These were quickly drilled to depths that could be reached by drilling methods and equipment then available. The geologists, in addition to locating surface structures, were interpreting subsurface structure through study of well logs.

This interpretation, as the writer knows from experience, was not entirely satisfactory because it depended on drillers' logs and examination of cuttings from the wells. The peak of discoveries for this period of concentrated testing of exposed anticlines came in 1910.

Interpretation of physiographic features was the next exploratory method to receive maximum attention and it produced a period of discovery that culminated in 1920. Study of foraminifera and core samples and improved drilling equipment and methods caused another peak of discovery in 1927.

Geophysical exploratory methods

XUM

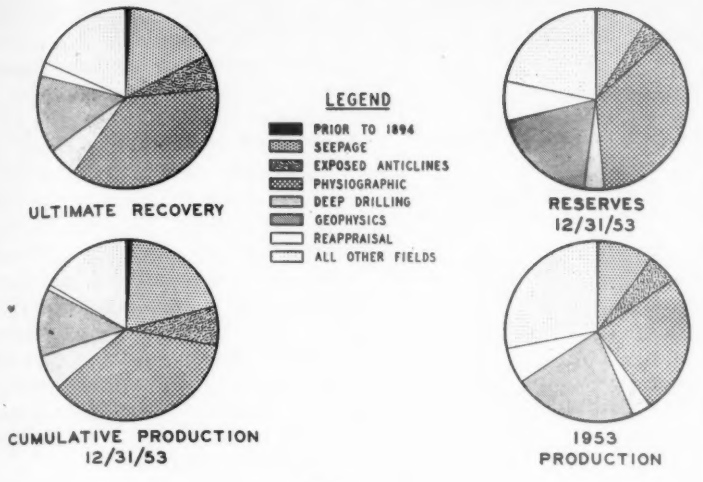


FIG. 7.

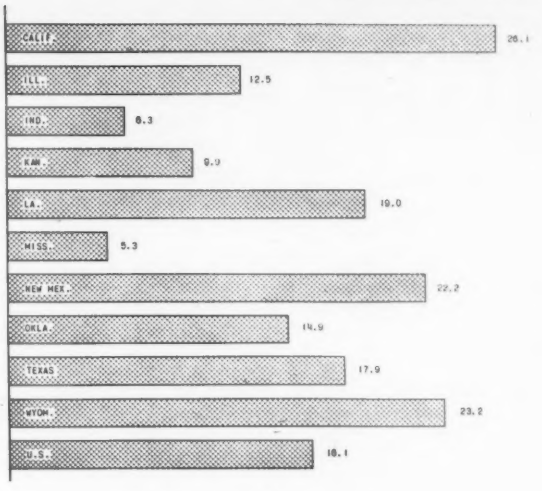


FIG. 9.

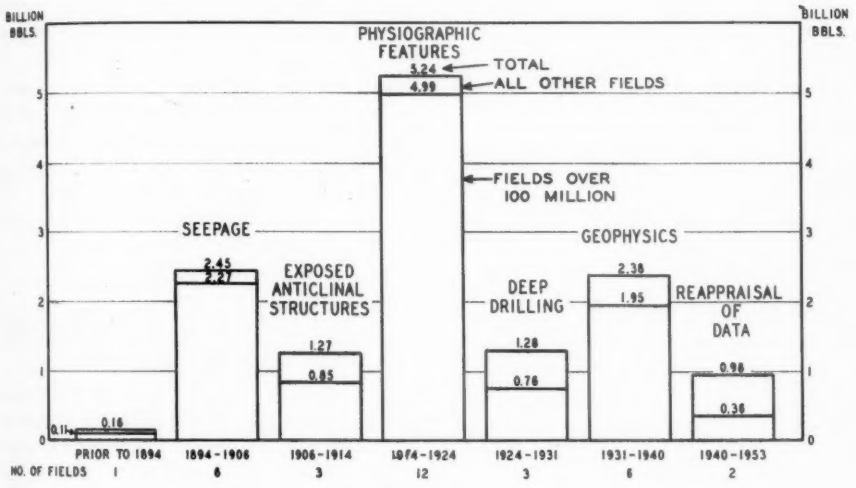


FIG. 8.

and electric-log correlations led to a new crop of discoveries that reached a top in 1937. There has been no pronounced peak of discoveries since the end of that era, although some excellent fields have been found. The period from 1940 to date might be named reappraisal of data or marking time or consolidating gains.

Discoveries Show One Cyclic Pattern With . . .

The waves of discovery attained in 1900, 1910, 1920, 1927, and 1937 are shown graphically in Fig. 6, reproduced from a recent article.[11] The estimates of ultimate recovery were made by the writer in September, 1953. G. C. Gester and G. M. Cunningham in 1943 were the first to designate the specific type of exploratory activity that dominated each wave of discovery.

A name tag on a peak does not signify that other kinds of geological investigation failed to find anything in that period. The major method of exploration always was aided and abetted by other exploratory method in use at that time.

It should be noted that the discovery record shown in Fig. 6 is by individual pools and that the estimated ultimate recovery of each pool is credited to the year of its discovery.

This method of segregating discoveries gives recognition not only to the geological thinking that finds a new field but also to subsequent analysis and exploratory drilling that leads to production from new pools on the same major structural feature. It is true that the discovery of a field is of greatest import to the industry because it adds a new structure to the list of producing fields and, further, it indicates the probability or possibility of finding other productive reservoirs on that structure.

Normal development of a field may result ultimately in the discovery of every potentially productive reservoir within the limits, both horizontal and vertical, of that field but it might require decades to attain that goal. Consider, for example, Buena Vista Hills: The first pay zone in this field was discovered in 1909 but the 27-B pool lay dormant until 1944 when it was found by an exploratory well located within the old limit of production after a considerable period of time spent in the analysis of subsurface data.

Torrey Canyon is another excellent example of "delayed" discovery: production from the upper Sespe was found at shallow depth in 1896 but the lower Sespe around 10,000 ft was not discovered until 1953; the writer does not know exactly what instigated this deep drilling but suspects that exploratory thinking was largely responsible for it.

. . . One Outstanding Feature

The physiographic features peak topped all others. It was during this orgy of discovery that such remarkable fields as Elk Hills, Huntington Beach, Long Beach, Santa Fe Springs and Ventura Avenue were found. The other eras of discovery included outstanding fields also. Brea-Olinda, Coalinga East and West, Kern River, Midway-Sunset, and Orcutt were found during the period when drilling near seepages was the major urge.

Concentration on exposed anticlinal structures was rewarded by such fields as Buena Vista Hills and Front, Cat Canyon West, and Coyote West. Kettleman North Dome was the largest field discovered during the deep drilling period. The geophysics era produced such fields as Coalinga Nose, Coles Levee North, Greeley, Rio Bravo, Santa Maria Valley, and Wilmington. Cuyama South and San Ardo have been the most prolific fields discovered since 1940, the year marking

FIG. 10.

the close of the wave of discoveries stimulated by geophysics.

The percentage of California's estimated ultimate recovery of crude oil contributed by fields discovered during each of the eras mentioned is given in the following table. The figures are estimates made by the writer in September, 1953.

Name of discovery era	Percentage of State's estimated ultimate recovery
Prior to 1894	1.2
Seepages	17.8
Exposed anticlinal structures	9.2
Physiographic features	38.1
Deep drilling	9.3
Geophysics	17.3
Reappraisal of data	7.1

It is evident that the center of gravity of discovery was in physiographic features, 34 years ago. Roy Barnes[10] reported that 42 geologists were employed in 1920 by 17 leading operators in California.

The writer has mentioned that there might have been 10 during the period 1900-1910 and perhaps 20 from 1911-1919. These few pioneers were active during the period when aproximately half of the estimated ultimate recovery, calculated by fields, of the state was discovered. These figures suggest that these old-timers certainly knew how to find oil.

Big Fields Still Constitute Major Reserves But . . .

It was pointed out in a recent article[11] that 33 fields having estimated recoveries greater than 100,000,000 bbl each had been the mainstay of California's oil economy. These fields are distributed geographically as follows: 14 in the San Joaquin Valley, 12 in the Los Angeles Basin, 2 in the Ventura Basin, 3 in the Santa Maria Basin, and 2 in the Central Coast Ranges. The distribution of these largest fields by era-of-discovery is shown on Fig. 7. The relative importance of the same fields as to ultimate recovery, reserves, cumulative production, and 1953 production is distributed to era-of-discovery on Fig. 8. Both of these figures are taken from the previously mentioned article.[11]

Fig. 8 may be summarized in the following manner. The 33 fields, which constituted only 13.5 per cent of all California fields, had 82 per cent of estimated total ultimate recovery and more than 78 per cent of estimated reserves remaining at the end of 1953. They were credited with 72 per cent of the production in 1953 and nearly 84 per cent of cumulative production to the end of that year.

It is interesting to note, furthermore, that the 12 big fields found during the physiographic features era produced 25 per cent of total production in 1953. Another half-dozen fields are approaching the 100,000,000 bbl ultimate recovery mark but these were excluded from the top group of 33 big fields. The inclusion of close-to-100,000,000 bbl fields for comparison with all other fields would make the percentage importance of large fields still more impressive.

. . . Production Is Exceeding Discovery Rate

California at the end of 1945 had 16.6 per cent of the nation's crude oil reserves whereas at the end of 1953 it had only 13.5 per cent. The end of 1945 is selected as the opening of the post-World War II period. This failure to retain position in the national picture may be due to California's high ratio of withdrawals to reserves or to a lack of intensive exploratory effort to find new oil.

California produced 9.2 per cent and 9.5 per cent of its crude oil reserves[12] in the years 1946 and 1953, respectively. Analogous figures for the balance of the United States are 8.1 and 8.2. California, furthermore, produced 18.5 and 15.8 per cent of national production in 1946 and 1953, respectively. Note that its percentage of production was considerably higher than that of reserves in both years. These comparisons indicate that this state is draining its reserves at a more rapid rate than is the balance of the United States.

California, furthermore, has not drilled its proper proportion of exploratory wells. During the 1946-1953 period it drilled only 5.5 per cent of all new-field wildcats and only 5.4 per cent of all new-field and new-pool tests in the United States. The latter include new-pool wildcats, deeper-pool tests and shallower-pool tests. It would seem to be expedient for this state to

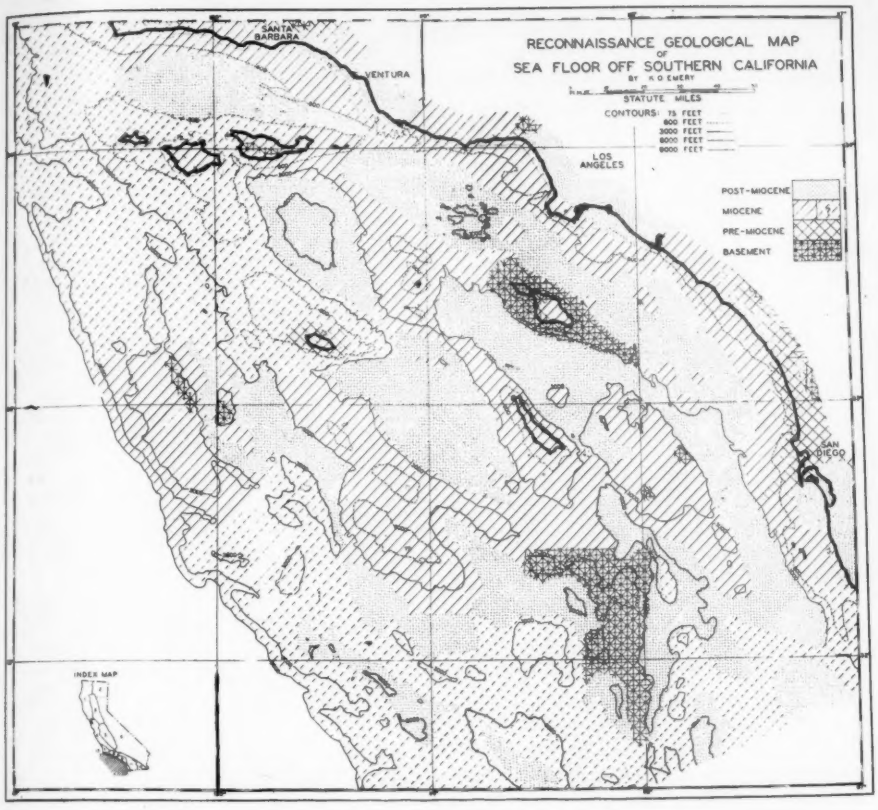


FIG. 11.

drill a percentage of total exploratory wells comparable to its percentage of total production or, at least to its percentage of total production in order to retain its position in the national picture.

Low Success Factor but High Acre Recovery

The success factor in exploratory drilling is comparatively low in California—5.5 per cent for new-field wildcats and 10.0 per cent for new-field wildcats and new-pool tests. The analogous figures for the nation are 11.2 and 16.3 per cent. These figures cover the 1946-1953 period. Despite the low success factor the rewards in barrels of oil found per foot of hole drilled have been excellent, as shown in Fig. 9 which is taken from a recent article.[11] The data on footage drilled in the different states are from F. H. Lahee's annual reports[13] and, on reserves discovered, are from annual reserves reports[12] by the American Petroleum Institute.

F. H. Lahee published[14] figures on the number of new-field wildcats drilled in the United States to find fields of varying ultimate recovery. His study covered the 3-year period, 1944 to 1946. The writer adjusted Lahee's orginal numbers to agree with corrections that the latter made in subsequent annual articles[13] and added three more years, 1947 to 1949, in order to compare California with the nation over a 6-year period. The results of this comparison are given here.

The conclusion should not be drawn from this last comparison that California is the most fruitful state in which to drill new-field wildcats. It merely shows that fewer wells were required to find a 50,000,000 or a 10,000,000 bbl field here than was average for the nation during a specific 6-year period. It is not, however, a discouraging comparison especially when fortified by the data shown on Fig. 9.

1944—1949	Number of new-field wildcats drilled to find one field having ultimate recovery of: 50 million or more barrels	10 million or more barrels
California	459	125
United States	858	183

What of the Future?

"The question has often been agitated especially in modern times. . . ." This is quoted from a personal journal (not the writer's) dated January 1, 1852. It is introduced, as a preface to comments on forecasts, in order to stress the point that these opinions are predicated on past experience and data available at any moment in the particular "modern times" in which we happen to be living.

The chap who wrote the journal from which the quotation came was, quite evidently, a gentleman of parts and thoroughly familiar with then-current ideas on chemistry, physics, steam engines, geology, and a multitude of other subjects. Some of his statements, although beautifully written, seem ludicrous to one reading them now. He was limited by what was known at that time.

The forecasts on California's oil supply that follow are given in no spirit of derision but only to support the thesis that it has been impossible in the past to appreciate the magnitude of petroleum supplies in this state. It is quite probable that observers ten years hence will read forecasts made in 1954 and will find it hard to believe that we could underestimate so grossly our future contribution to the industry.

Listed are historic published estimates of California's reserves of crude oil and the production from the time of estimate to the end of 1953.

Year	Estimated reserves million barrels	Production: from date estimated to end 1953—million barrels
1908	4770	9499
1915	2272	8960
1921	1700	8334
1926	1988	7411
1935	3719	5490
1940	3199	4355
1944	3345	3059

Note that the first estimate that forecast sufficient crude oil to last until the end of 1953 was made in 1944.

Possible new oil provinces in the state were summarized briefly in 1941.[15] Cursory mention was made of the Salinas and Cuyama Valleys, the sites of subsequent oil discoveries. A similar but more extensive study was prosecuted in 1950.[16] Two figures are reproduced from that report. (Figs. 10 and 11.)

Fig. 10 shows the Central Coast Ranges which include the oil fields of Salinas and Cuyama Valleys, discovered after the 1941 report. Nothing startling in the way of discovery has occurred in this particular region since 1951, but the maps suggests that there are large areas of sedimentary rocks that have not been disproved by drilling.

Fig. 11 was a part also of that 1951 report. It is reproduced here because of current interest in off-shore possibilities. California has less area available for prospect drilling under reasonable depths of water than has the Gulf Coast. It was calculated for the 1951 report that only 1400 sq miles underlay water at depths from 0 to 10 fathoms and 11,700 sq miles at depths from 0 to 100 fathoms.

Prospects May Be Prematurely Condemned

Possible oil regions are occasionally written off before enough wells have

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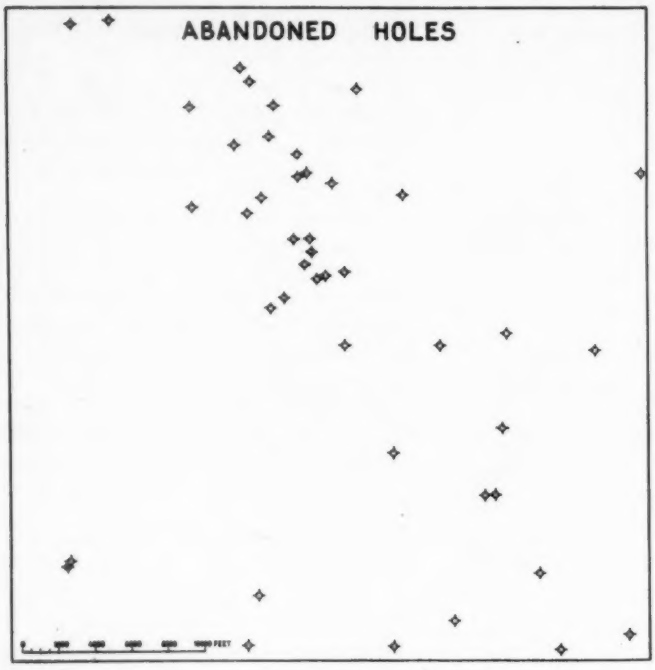

FIG. 12.

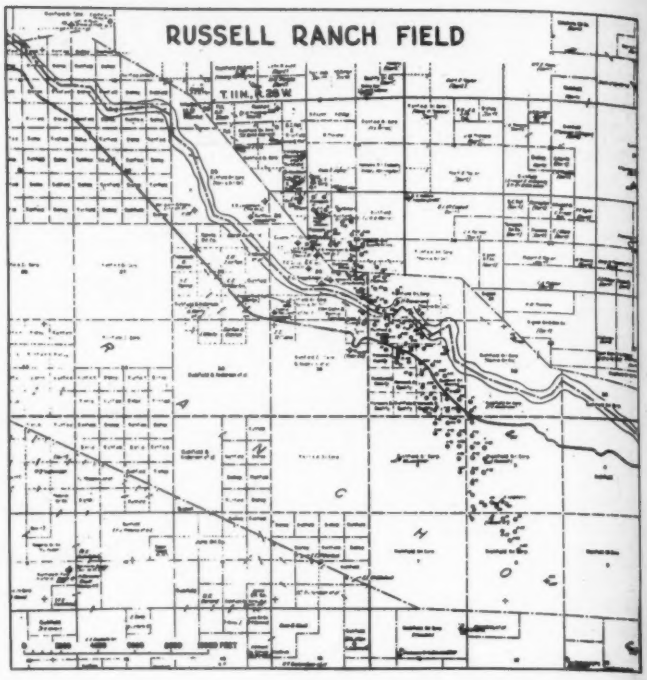

FIG. 13.

been drilled to prove that there is no possibility of obtaining production. Fig. 12 shows the location of all abandoned dry holes in a certain area. The distribution of these dry holes gives little incentive for further exploratory drilling except, perhaps, in the northeast and southwest portions.

The Russell Ranch field is shown in Fig. 13, from which the abandoned holes on Fig. 12 were traced. It is granted that most of the dry holes were drilled after the field was discovered but, despite that fact, the two figures demonstrate how a prospective oil field might be missed successfully even though a considerable number of dry holes were drilled.

The discovery well of Russell Ranch, incidentally, if moved only a short distance in the right direction would have been another dry hole.

Numerous oil fields have lain undiscovered for a long time because some dry holes in its neighborhood convinced a few people that there was no chance of finding oil in the area and these few people spread the bad news and shortly the area was condemned.

Reserve Level Should Hold

California's reserves of crude oil were estimated to be about four billion barrels at the beginning of 1954.[12] Indications are that our reserves will hover around that figure for several years in the future. This desirable situation will be attained through: discovery of prolific fields off-shore and on-shore; discovery of new pools in close proximity to presently producing fields or below productive zones in those fields; extensions of currently proved limits of productive areas; application of more efficient primary recovery methods; more extensive utilization of fluid injection in secondary recovery operations; reappraisal of currently available geological data; and research in the origin and characteristics of sedimentary rocks and basins that yield petroleum.

A comprehensive conservation law would help to prevent waste and to keep our reserves at a comfortable level. A more aggressive, optimistic exploratory campaign should increase our rate of discovery. It will cost real money to find and develop the big fields below thrust faults and off-shore. California's exploratory and operating men have repeatedly shown their ability to find and produce oil here when prospects appeared gloomy. It will be more difficult in the future to find oil, but it will be done.

A peculiarity of many of California's reservoirs influences the writer to remain optimistic about future supply here. Years of observation have convinced him that the reservoirs refuse to conform to mathematical calculations showing how much oil they are supposed to give up. The action of many of the old fields is astonishing and at the same time extremely satisfying. Consider, for example, three fields that apparently were approaching senility as implied below:

1935: "Long Beach, Huntington Beach, Santa Fe Springs, and lesser lights are now staid old fields of creaking pumpers."

Those three fields have yielded nearly a billion barrels of crude oil since that statement was made. When our "staid old fields" act thus, one must be optimistic about the future.

Acknowledgment

The writer extends his sincere thanks to H. L. Driver for helpful criticism of the text and particularly for his compilation of Chart 1; to the American Association of Petroleum Geologists for permission to use figures previously published in the Bulletin; and to the Standard Oil Company of California for permission to prepare this article.

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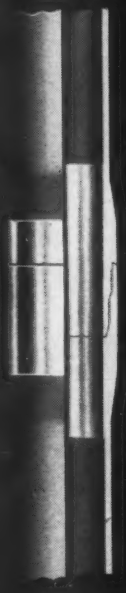

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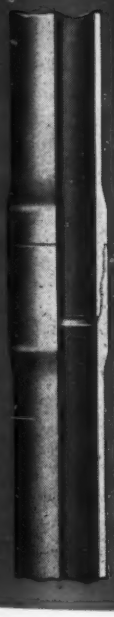

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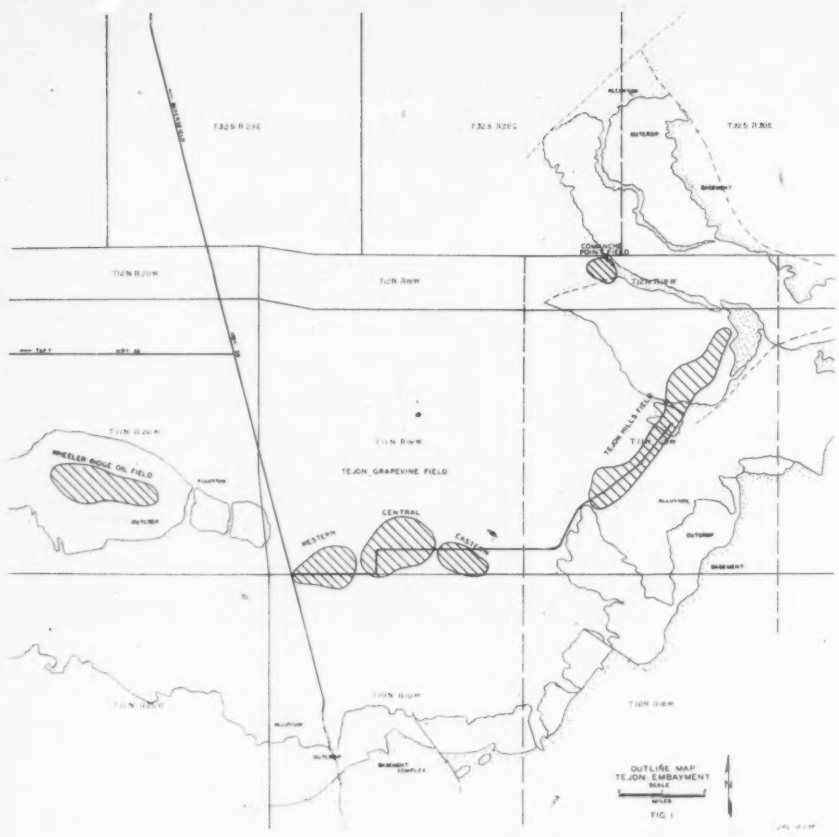


FIG. 1.

The Tejon Embayment

The boom is on in this lush central California area where favorable geological conditions and minimum drilling, completing, and operating problems favor development

JOHN P. LAVERY, JR., and JOHN B. VALLELY

ONE of the busiest drilling areas in California at the present time is the Tejon Ranch in the San Joaquin Valley. Indications are that it may become busier as time goes on. The reason for most of the activity is Reserve Oil and Gas Company's recent Olcese pool discovery in the 18-year-old Tejon-Grapevine field. This activity occurs on a portion of an old Spanish land grant and is known geologically as the Tejon Embayment, Fig. 1.

The Tejon Embayment is located in the extreme southeasterly portion of the San Joaquin Valley on the north flank of the Tehachapi mountains and on the west flank of the southernmost part of the Sierra Nevada mountains. The mountainous areas consist of Jurassic basement rock with a border of Pleistocene to Eocene sediments exposed between basement and valley alluvium. The forces that uplifted these two mountain ranges, nearly at right angles to each other, developed complex fault patterns and numerous unconformities.

In 1936, Reserve Oil and Gas Company discovered the first oil upon completion of well No. 33-2, section 33, T. 11 N., R. 19 W., in what is now the Tejon-Grapevine field, central area. This well and several subsequent wells were completed in the Reserve sand of the Upper Miocene Pulv zone. Richfield Oil Corporation, in 1943, discovered the Chanac-Santa Margarita Transition zone oil sand in the eastern area. This zone was found productive in the western area by British-American-Capital Company in 1946.

Completion of Tejon Hills Oil Company well No. 2, section 10, T. 11 N., R. 18 W., in 1948 initiated a series of discoveries that are parallel to and apparently controlled by the Springs fault. This productive area, now called the Tejon Hills field, is approximately 6 miles long and ½ mile wide with a northeast-southwest trend.

Outlook

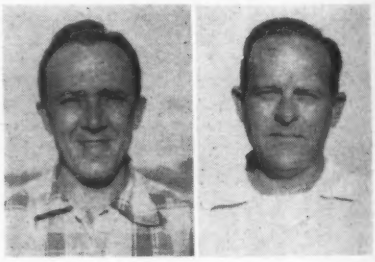
The Tejon Embayment has not been subjected to intensive exploration. Fig. 2 will reveal two important keys to future exploration—(1) the major unconformity at the top of the Valv zone, and (2) the massive basalt wedge that overlies Lower Miocene, Oligocene, and Eocene sediments throughout the area.

West of Tejon Hills field and north of Tejon-Grapevine field relatively few deep wells have been drilled. Encouraging shows, however, have been found in the Santa Margarita, Valv and Pulv zones in various parts of the area. The most encouraging of these are the strong indications of transition and Pulv zone production overlying the Olcese pool in section 34.

The main difficulties involved in exploration of the Transition and Pulv sands are the overlapping, lenticularity and facies changes of the sediments combined with a complex fault pattern.

Below the Valv unconformity, Middle Miocene sediments appear to have a more regular depositional pattern.

The Authors



John P. Lavery John B. Vallely

John Lavery, Jr., is exploration geologist and engineer for Reserve Oil and Gas Company in Bakersfield, California. He graduated from the University of California in Berkeley in 1949 with an AB in geological sciences. After one year of graduate studies he went directly to work for Reserve Oil and Gas Company. In 1954 he assumed additional duties as engineer.

J. B. Vallely is production superintendent for Reserve. He is a graduate of the University of Southern California, with a BA in geology, and the Harvard Graduate School of Business Administration. Prior to joining Reserve Oil and Gas Company in 1952 as a petroleum engineer, Vallely had worked for Union of California and Richfield Oil Corporation.

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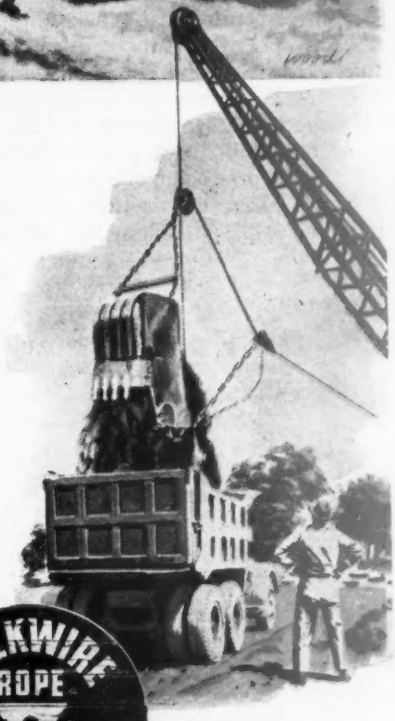

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Present evidence indicates the probability of structural rather than stratigraphic trapping in the Relizian and Saucesian sections.

The sediments below the Basalt are almost completely unexplored in the bulk of the Tejon Embayment. The wedging of the Basalt is an important clue to the old underlying structures in zones that have been found to be the most prolific producers in other portions of the San Joaquin Valley. These zones are productive at Tejon Hills, Wheeler Ridge, and along the east side of the San Joaquin Valley, Edison area.

By the nature of the embayment there is lapping out of sediments against basement. The existence of traps thus formed is shown by one marginal producer in section 24, T. 11 N., R. 19 W. This well, completed in the "Lo" zone, has produced 15 bbl per day of 33 deg oil from 3 ft of sand for over 1½ years with little or no apparent decline.

Two wells in the area have established the presence of Eocene sediments under a portion of the Tejon Embayment at depths of 11,000 to 13,000 ft. As exploration moves basinward, structures should be revealed which it is felt will yield traps of substantially greater areal extent than basement pinch-outs. This coupled with the thicker sand sections characteristically found below the basalt gives the region great promise for the future.

There are two distinct proven producing areas in the Tejon Embayment. They are the Tejon-Grapevine field and the Tejon Hills field, Fig. 3 and 4. Both are multiple zone fields. Although depths of producing horizons vary greatly between the two fields, the geologic factors that govern the entrapment of oil are somewhat similar.

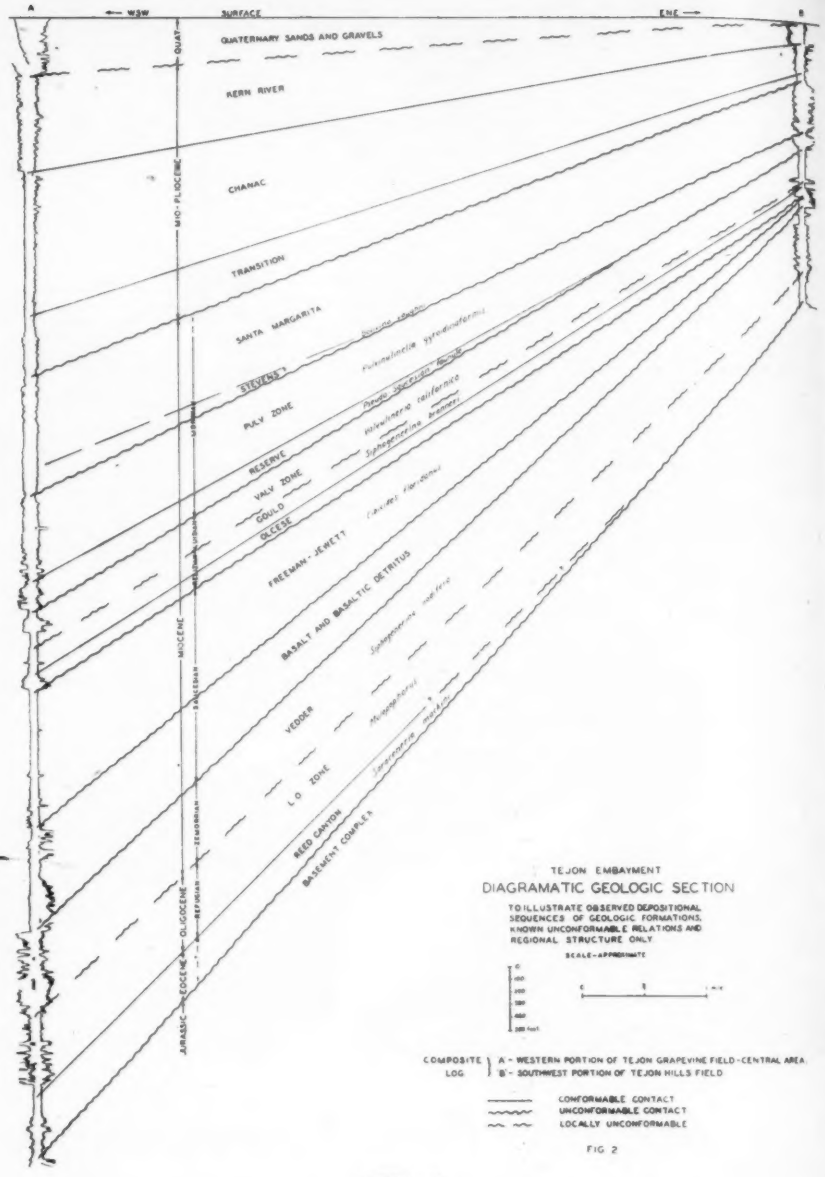
Tejon-Grapevine Field

The Tejon-Grapevine field, as shown in Fig. 1, is divided into three distinct areas of production:

1. **Western area**
2. **Central area,** and
3. **Eastern area**

Practically all current production in the western area and eastern area is from Transition zone sands. Effective well depths in the western area range from 2500-2600 ft and the productive intervals vary from 50-125 ft on a dome-like structure with stratigraphic trapping.

In the eastern area, well depths are 1860 to 2690 ft with productive intervals of 40 to 265 ft. The structure is monoclinal with permeability governing the entrapment of oil. The sand in both areas is fine grained to coarse and pebbly with a green clayey matrix. The oil is approximately 16-18 deg gravity;



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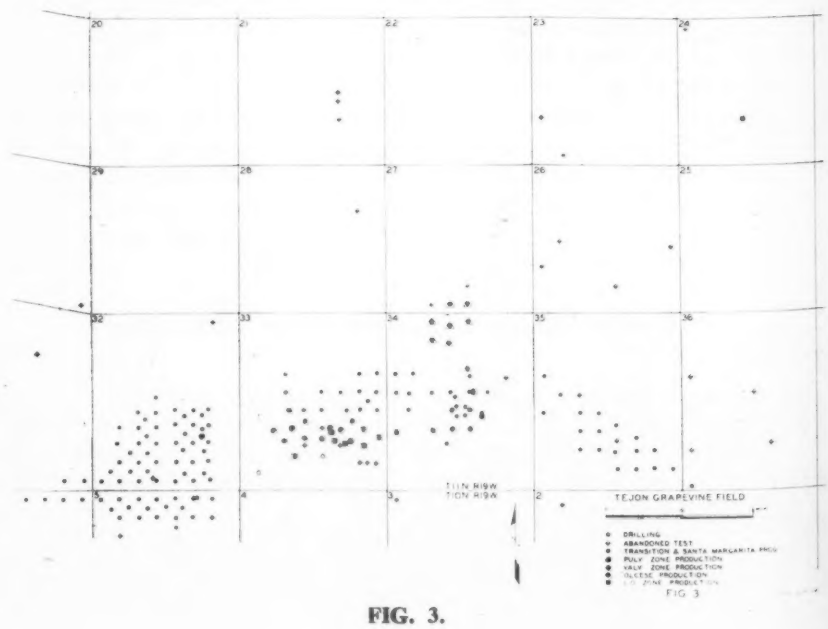

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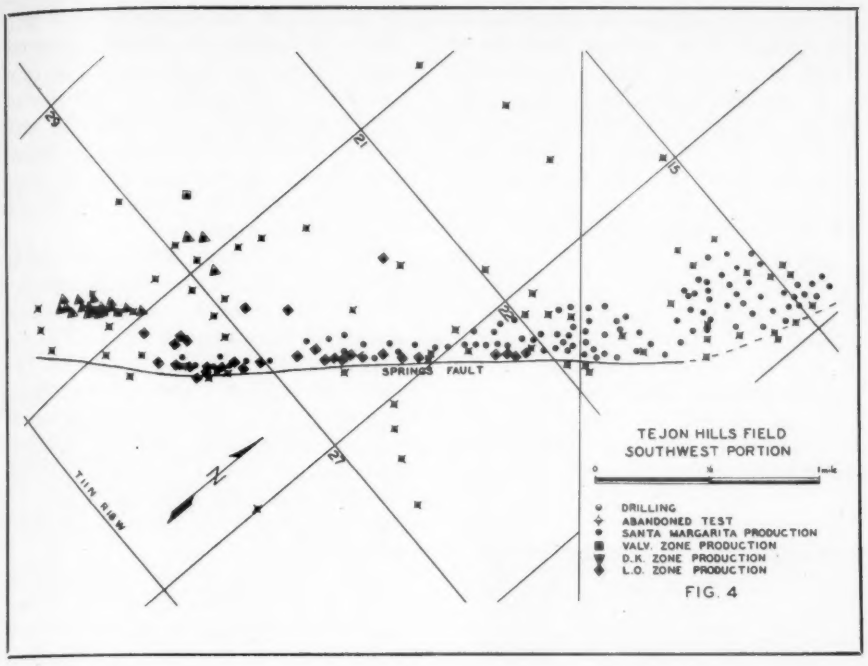

FIG. 4

permeabilities vary between 200 and 1200 millidarcies; and recovery is estimated at 350 bbl per acre foot.

The early wells were drilled in with water base mud. It soon became apparent that water in the mud was seriously impairing productivity. Running sand conditions resulted and the clay matrix in the pay zone swelled, thus reducing permeabilities. The running sand conditions were handled with some success by gravel packing liners. The use of oil base drilling fluids in recent five-spot completions has apparently corrected the problem of permeability reduction and higher productivity indices have resulted.

The central area has five major producing zones, Transition, Santa Margarita, Pulv, Valv, and Olcese.

Transition zone production is from 10 wells with geologic and productive characteristics similar to both western and eastern areas, however, the structure is a gentle fold.

The Santa Margarita sand wells range in depth from 2700 to 2900 ft with 60 to 150 ft of productive interval. The sand is fine to medium grained with permeabilities of 600-1500 millidarcies. In general it is definitely gray in appearance in contrast to the green color of the Transition sand. Gravity of the oil is about 18 deg and estimated recovery is 200 bbl per acre foot. The trap is partially stratigraphic with gentle folding.

Pulv Zone

The Pulv zone ranges from 3000 to 4600 ft in depth. There are 6 sands in the zone, the most productive of which is the Reserve sand at about 4400 ft. It is about 100 ft thick. This sand, discovered by Reserve Oil and Gas in 1936, is bluish to brownish gray, very fine grained and well sorted with a somewhat clayey matrix. The structure is a narrow anticline plunging to the west with the sand shaling out on the south flank.

This is the most difficult of the zones to produce because of the running sand conditions. It is essential to drill the wells with oil or oil base mud, and even then when the zone becomes sufficiently depleted the sand troubles start. The most successful completions are with 60 mesh liners. Here also the swelling of interstitial clays on contact with water base mud decreases the permeability drastically. The zone yields 23 deg gravity oil and the recovery is estimated at approximately 200 bbl per acre foot. There is an active water drive.

Valv Zone

The Valv zone has 1 major productive sand about 80 ft thick at a depth of 4700 ft. This zone was discovered by Reserve Oil and Gas Company in 1951, in well Reserve-E. W. Pauley No. 58-33. The sand is light gray, fine to medium grained, well sorted and clean. The structure is on east-west trending anticline with the sand shaling out on the south flank.

The wells are drilled in with water base mud and most of them are completed through gun perforations. Production problems are relatively minor. Initial PI's of the wells ranged from 0.5 to 1.0 bbl per day per psi. An active water drive as well as an expanding primary gas cap provide the reservoir energy.

Olcese Pool

The Olcese pool was discovered in May 1954 in well No. 42-34, drilled jointly by Reserve Oil and Gas Company and E. W. Pauley. Delineation and development of this pool is the cause of most of the current activity in the area. At this writing, 5 strings of tools are operating and 8 wells have been completed in this pool with no dry holes.

The black oil portion of the Olcese zone is a heavy conglomerate with a medium grained, crisp, clean oil sand matrix. The gas cap consists of interbedded fine sands and shale. Permeabilities are as high as 2000 millidarcies. Gravity of the oil is 28.5-30 deg and the solution ratio is approximately 400 cu ft per bbl. Structure is apparently a faulted anticline, productive limits of which have not as yet been determined.

Productivity indices of the wells are for the most part 1.5-2.5 bbl per day per psi. There is as yet no appreciable decline in bottom hole pressures which are essentially hydrostatic. The black oil zone varies from 40 ft to 170 ft in thickness with approximately 150 ft of gas cap above that. The pool has not been on production long enough to reveal the presence of a water drive, but the large gas cap should provide an adequate gas drive. In keeping with good production practice, the wells are being held to about 200 bbl per day each.

Discovery well was completed with a combination string and 60 mesh perforations. Subsequent wells were completed through gun perforations. No difference in initial PI's have been ob-

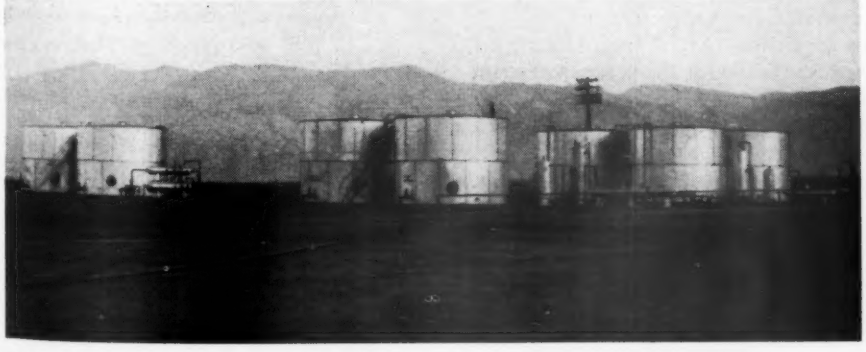
FIG. 5. Reserve Oil and Gas Company's tank battery for new Olcese pool.

served that can be attributed to the different completion practices. All the wells have been drilled in with water base mud and clean up very rapidly.

Tejon Hills Field

The Tejon Hills field has four major productive zones — Santa Margarita, Valv, "D. K." (regionally called Vedder), and "LO."

Santa Margarita production is found in sections 2, 10, 11, 15, 21, 22, and 28, at a depth range of 365 to 550 ft and with a productive interval of from 20 to 200 ft. The sand is light gray, coarse grained, massive, and somewhat clayey. Accumulation is in numerous fault blocks and minor folds. The eastern limit of production is controlled by the Springs Fault, surface evidence of which is a line of springs and a small near vertical escarpment in Pleistocene gravels. Closure to the northeast is apparently due to faulting. Production varies from 20 to 100 bbl per day of 28 deg oil. Permeability varies from 170 to 5600 millidarcies.

The Valv zone, discovered in 1950 by D. K. Partnership well No. 13-28, is productive in as many as 6 sands of limited areal extent at a depth range of 750 to 1325 ft in sections 21, 22, and 28. These sands are brownish gray, fine grained, firm and clean. The Valv zone has a definite facies change along strike from almost all shale in section 29 to all sand in section 21 and then laps out against the rising basement complex to the northeast. Initial production is 100 to 200 bbl per day of 29 to 31 deg oil. Permeabilities vary from 120 to 3200 millidarcies. Accumulation is due to stratigraphic trapping involving the Springs Fault and minor cross faults.

The "D.K." zone was discovered in 1950 by D. K. Partnership 2 well No. 73-29. This zone has several productive sands at a depth range of 1500 to 2500 ft in sections 20, 21, and 29. The sands are light gray green, fine grained, and somewhat ashy. Accumulation is due to stratigraphic trapping, folding, and faulting. Initial production is 150 to 300 bbl per day of 33 to 34 deg oil. Permeabilities vary from 40 to 8000 millidarcies.

The "LO" zone was discovered in 1952 by D. K. Partnership 2 well No. 183-29. Production is limited to a few wells in section 29, at a depth of about 2150 ft, and one well in section 20 at 3700 ft. The sand varies from 20 to 75 ft thick and is coarse, granitic, ill sorted, and dirty, with relatively low permeability. Initial production is 80 to 125 bbl per day of 33 deg oil. The accumulation appears to be largely stratigraphic.

The distinguishing feature of the Tejon Hills field is the relatively high production of high gravity oil from shallow depths. Wells producing from Santa Margarita can be spudded and completed in about four days with slotted liners the main type of completion. Deeper zone wells can be spudded and completed in about nine days.

A solid string of casing cemented through the zone and selectively gun perforated is the usual completion practice. The wells are relatively inexpensive to drill which enables the operators to develop on a 2 to 5 acre spacing pattern. This combined with an active water drive and good permeabilities should make the ultimate recovery high, probably in the order of 400 bbl per acre foot.

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* * *

MINIATURE OIL FIELD

R. E. "Toad" Parker, warehouseman for Plymouth Oil Company in the San Patricio County (Texas) area, puts the finishing touches to his model oil field layout, complete in every detail and to correct scale, and winds up a painstaking job which took up hundreds of spare-time hours during the past several months.

In addition to the drilling rig, with its associated mud pits, pumps and boilers, a completed producing well can be seen in the immediate foreground, connected to the separator and tank battery in the distance. At left is a pumping well, to make the set-up complete, though luckily Plymouth's wells in this district don't often need such artifiicial respiration. The battery of trucks in the "open country" represents one of Plymouth's seismograph units. The vehicle to which the network of cables is connected is the recording truck, and the white "buttons" are the sensitive geophones which pick up the earth vibrations. Beyond the recording truck is the equipment used to drill the shot holes.

Geologist "Arch" Lair, looking on, is responsible for the geological structure underneath the miniature field, including the very slick paint job. He ought to be proud of that drilling location—looks like the bit's headed for a thick, black pay zone!

The model oil field is on exhibition in the lobby of Plymouth's district office at Sinton, Texas.

From The Pioneer, Plymouth Oil Company magazine. Photo by Bill Thompson.

Since World War II, more utility gas is sold every year than the total amount sold in the first 100 years of the gas industry's history.

Down-the-Well Heating

Gas-fired hot water system proves successful in Yorba Linda field, California

E. W. WALKER

OVER the years many methods of "down-the-well heating" have been tried to increase production or reduce waxing problems. Methods tried have included various types of electrical heaters, steam, hot oil, and hot water circulating systems, each with varying degrees of success. In order to make the proper selection and obtain the most economical results, each application must take into account the depth of hole, casing size, viscosity and gravity of fluid, cut, salinity, and available heating medium.

In the Yorba Linda field, Orange County, California, the Western Gulf Oil Company recently obtained production at an average midpoint depth of 400 ft. The crude is of 12.8-deg API gravity having a viscosity of 45,000 SSU at reservoir temperature of 85 F, and cuts from 20 to 50 per cent of fresh water.

Initial production in the first well declined rapidly from 20 to 8 bbl per day.

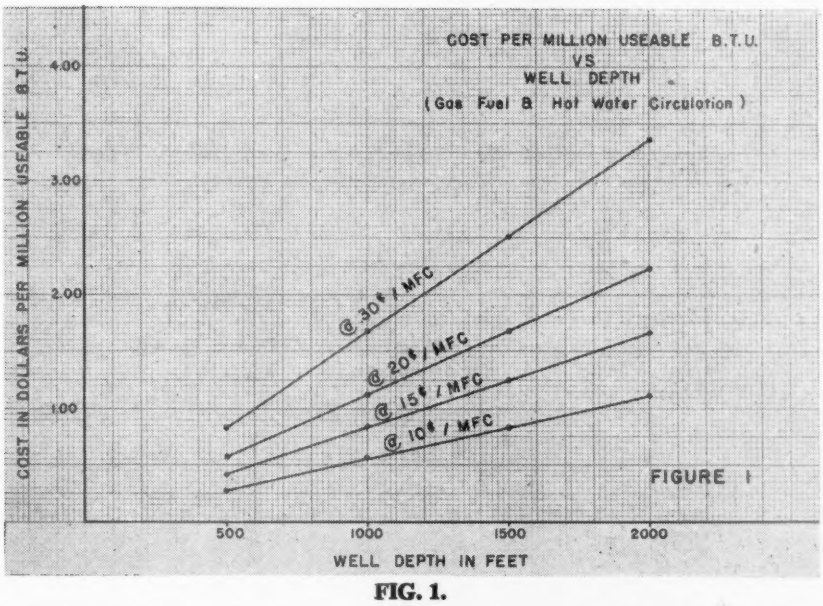


FIG. 1.

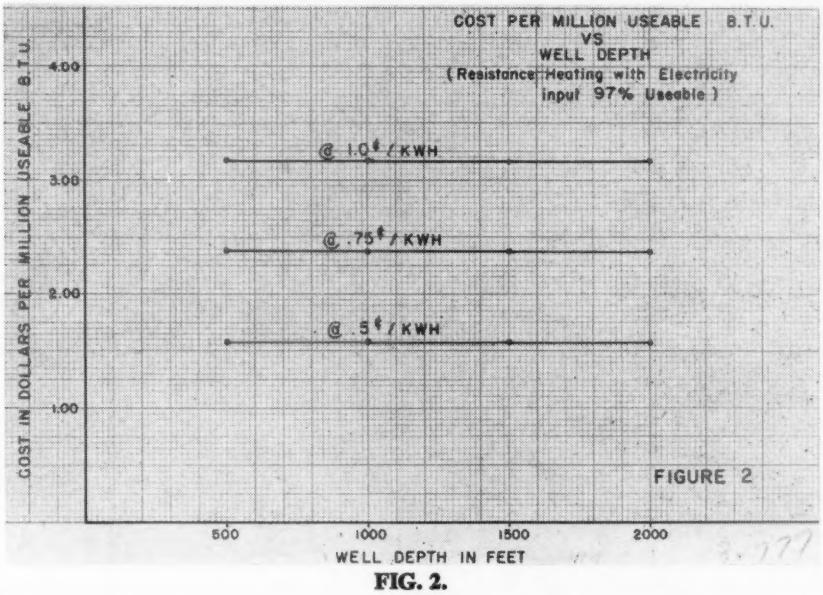


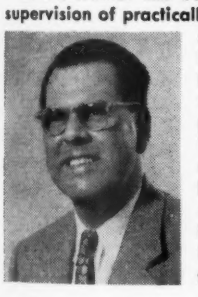
FIG. 2.

As a result, before proceeding with a development program, it was decided that down-the-well heating should be tried and evaluated. Heat was applied and production increased gradually until it was again up to 19 bbl per day and seemed to level out at that point. Shutting off the heat resulted in almost immediate decline in production. The beneficial effects of the heat in increasing production were very apparent and encouraged continued development of the leases. Ten wells have been drilled to this zone and each one has responded favorably to heat.

Before selecting the heating method, a study was made to determine which source of energy (gas or electricity)

EXCLUSIVE

The Author



E. W. Walker has been in charge of supervision of practically all surface operations at the Los Angeles office of Western Gulf Oil Company since 1946. Among other activities, he has handled drilling contracts, sales, and is currently engaged in making recommendations for offshore drilling programs, including platform and equipment design. He was graduated from Stanford University in 1930 with a BS degree in mechanical engineering. He worked for the General Electric Company until 1934 when he joined the Kettleman North Dome Association as mechanical engineer. His work there was principally in the supervision of surface operation, pipe line systems, compressor plants, etc. In 1943 he left Kettleman North Dome Association to join Western Gulf as mechanical engineer in the Bakersfield area. He was engaged principally in the supervision of lease gathering and treating systems.

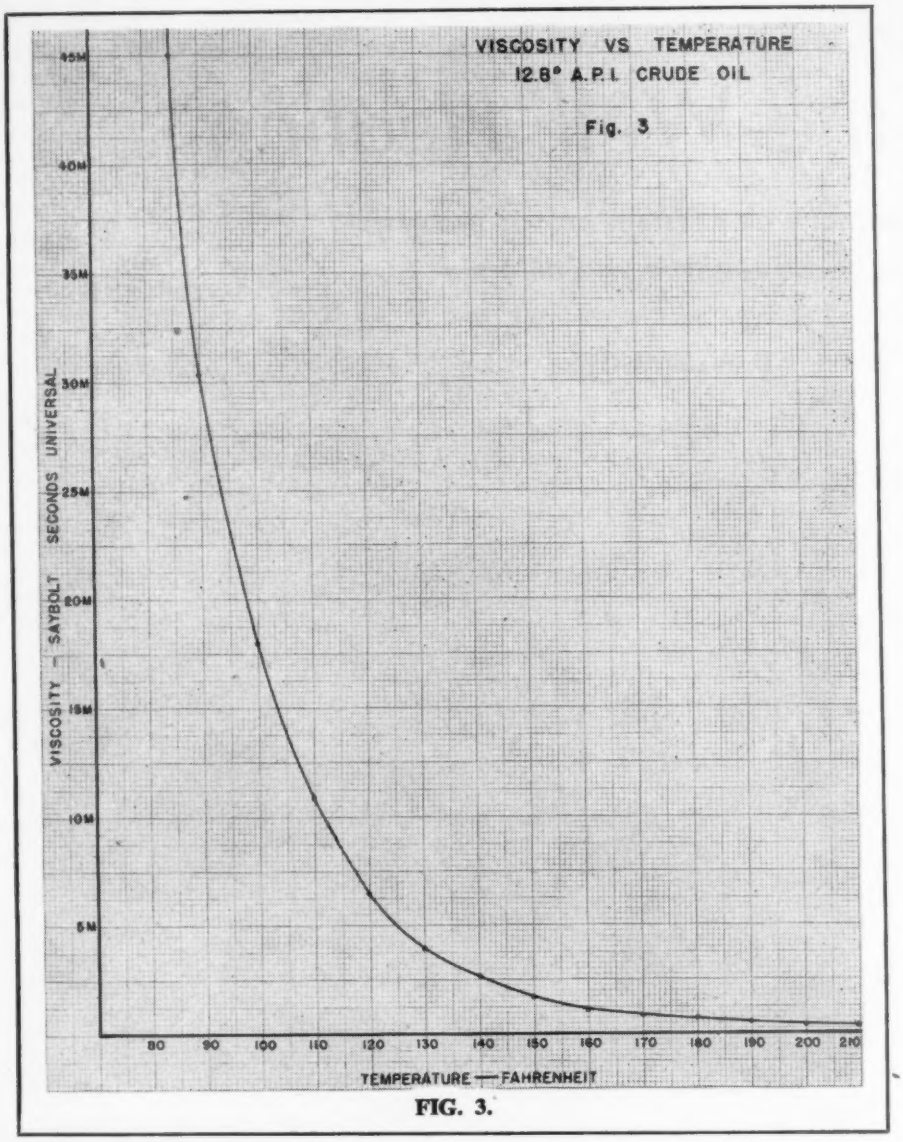
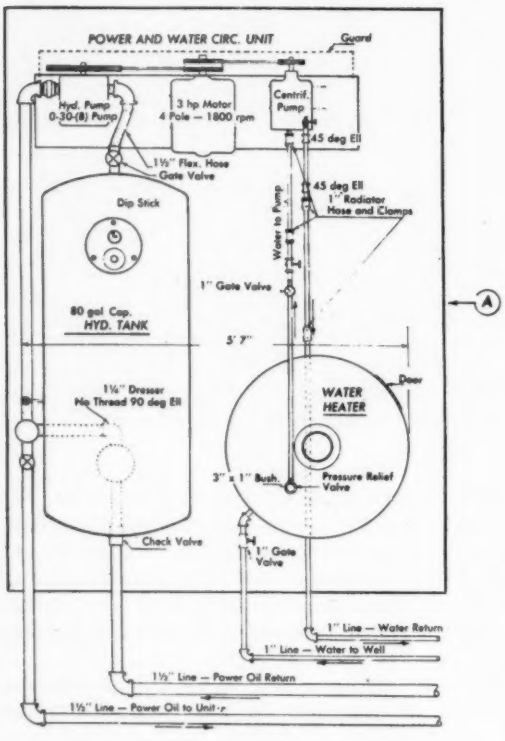


FIG. 3.

could be used most economically. This study showed that natural gas, although purchased at commercial rates, would be the cheaper fuel to use. Consequently a gas-fired hot water circulating heating system was designed and installed. This system also permitted the use of bottled propane gas during preliminary tests, thus deferring investment in gas lines until the project was proved.

The discovery well was completed at 500 ft with a 7-in. perforated liner across the productive interval from 300 ft to 500 ft. High viscosity was believed to be the main reason for rapid early decline in production. To combat this, it was decided to put sufficient heat into the oil so that some warming of the sand in the vicinity of the well bore would be realized. In order to accomplish this, it was desirable to install as much heat exchange surface as possible in the well bore. This was done by using finned tubing. Two types have been tried. Spiral wrapped tubing was used first and now finned tubing with vertical parallel fins is being tested, as it was felt that this type might be less susceptible to fouling. So far both have proved equally effective. The finned tubes selected were ¾-in. ID, having approximately 2.7 sq ft of surface per lineal foot. At least 100 ft of ¾-in. finned tubing is suspended 10 ft off bottom with two 1-in. pipe strings from the surface to complete the circulating system through which 220 F hot water 40 psi system pressure is circulated at a rate of approximately 8 gpm.

Two sources of energy for well heat-



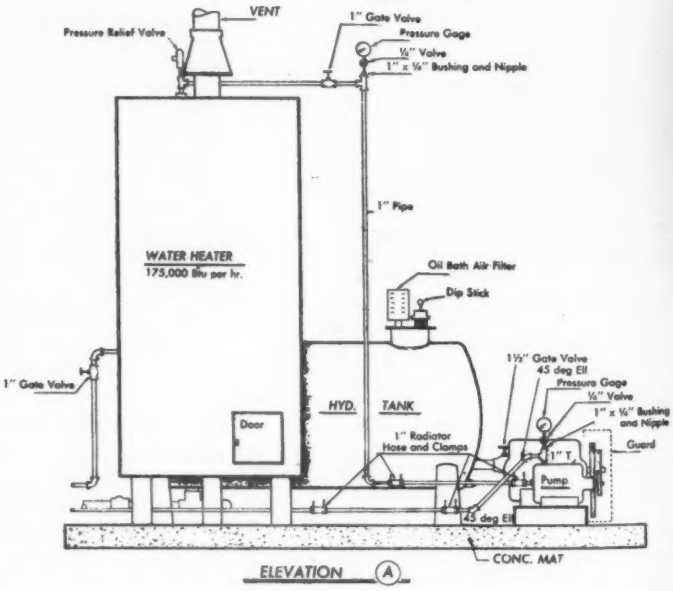


FIG. 4.

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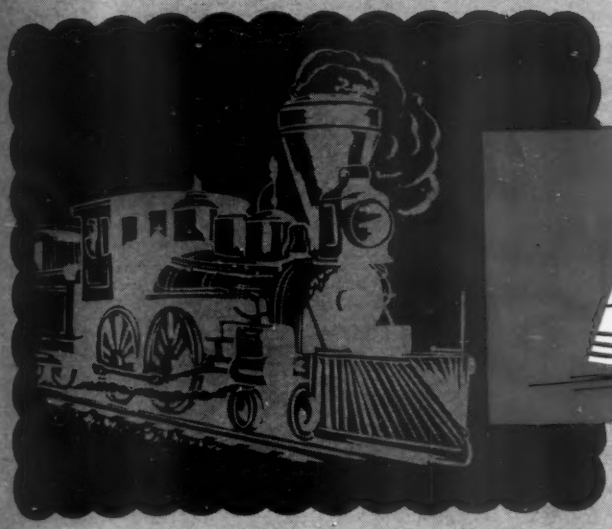

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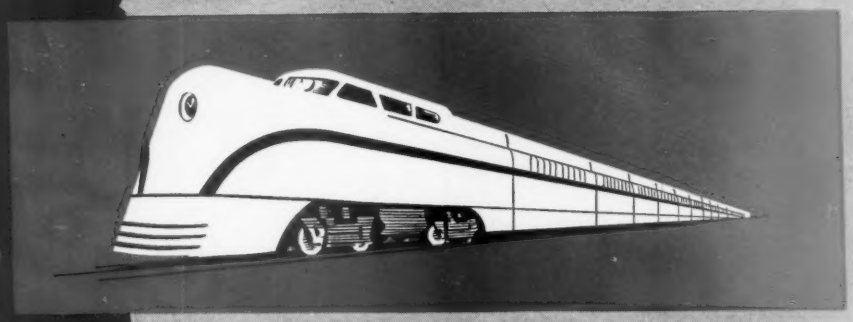

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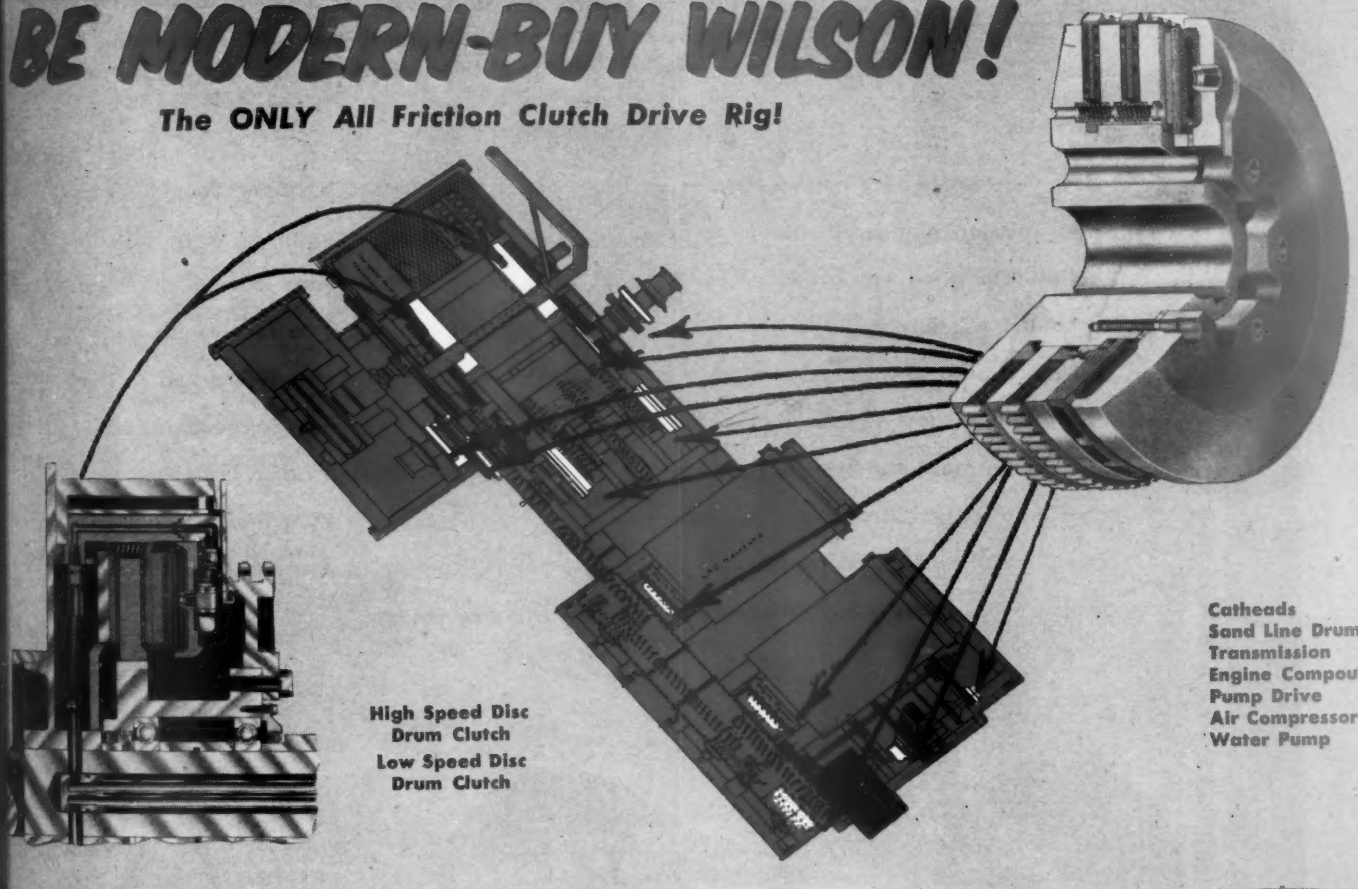

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Natural gas is available at 30 cents per Mcf, or 30 cents per 1,000,000 Btu, and electricity is available at 1 cent per kwhr, or $3.10 per 1,000,000 Btu. In this instance and on the basis of initial thermal energy, electricity costs 10 times more than gas. When utilization efficiencies are considered, however, the margin is reduced to 3 to 1 in the case of the 500-ft well and would break even on a 1900-ft hole.

With a hot water circulating system using gas as a fuel, there are two main sources of heat loss. Stack losses at the heater account for 30 per cent of the input heat. Radiation, conduction, and convection losses in the piping system between the heater and the well fluid account for another sizeable loss. The magnitude of such loss is variable, depending upon depth of hole, size of conductors, temperature of circulating fluid, and rate of circulation. See Table I for a comparison of these losses. In the case of the 500-ft Yorba Linda wells, these losses amount to approximately 34 per cent leaving at net usable heat in the fluid of 36 per cent of the input energy.

By comparison, if electric energy were used in the form of a resistance heater, the net usable heat would be approximately 97 per cent of the input energy.

Table I shows the heat dissipation from a typical hot water circulation system in wells of various depths assuming an oil equivalent production rate of 50 bbl per day, a water circulation rate of 8 gpm, with temperature increase of oil production from 85 to 145 F.

Data developed in this table has been used as a basis for preparing Figs. 1 and 2 showing the cost per million Btu of usable heat at various well depths and at various fuel costs.

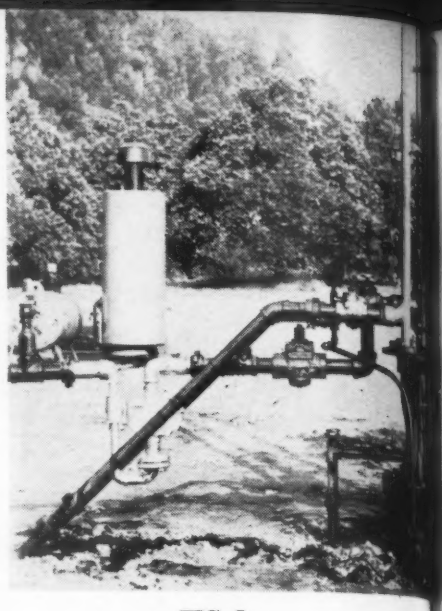

FIG. 5.

From Table I and Figs. 1 and 2, it can be readily be seen that as the well depth increases, the usable energy available from the circulation system becomes rapidly less, thus decreasing the attractiveness of this type of system in deeper holes.

The per cent of useful heat may be increased by increasing circulation rates, adding more heat exchange surface in the fluid and/or by insulating the circulating strings. It is recognized that putting some of these refinements into practice presents problems that are not always readily solved. Each application of heat down the well should be considered from all angles, including its practicability from the standpoint of installation, maintenance, and daily operating attention. Often these considerations will indicate that some increases in efficiency should be sacrificed in the interests of simplicity.

Fig. 3 shows the viscosity curve for the 12.8 API gravity Yorba Linda crude plotted on a linear scale. From this curve we find that a temperature rise of 60 F, from 85 F to 145 F, reduces the viscosity from 45,000 SSU to 2200 SSU. Assuming 20 bbl per day

TABLE 1. Heat dissipation from typical hot water circulation systems in wells of various depths.*

	Well depth			
	500 ft	1000 ft	1500 ft	2000 ft
Circulating systems				
Temp. water—In deg. F	220	220	220	220
Temp. water—Out deg. F	186	174	155	150
Rate of Water Circulation—gpm	8	8	8	8
Heat loss to stack—Btu/hr.	50,500	73,500	102,500	116,500
Heat loss to earth—Btu/hr.	57,500	128,500	199,500	236,500
Heat—useable				
To production—Btu/hr	20,000	20,000	20,000	20,000
To prod. formation—Btu/hr.	40,000	24,000	18,000	14,000
Total heat to burner—Btu/hr	168,000	246,000	340,000	387,000
Btu to stack—% total	30	30	30	30
Btu to earth—% total	34	52	58	61
Btu useable—% total	36	18	12	9
Gas cost per 1,000,000 useable Btu				
At 10 cents per Mcf	$ .28	$ .56	$ .83	$ 1.11
At 15 cents per Mcf	.42	.83	1.25	1.67
At 20 cents per Mcf	.56	1.11	1.67	2.22
At 30 cents per Mcf	.83	1.67	2.50	3.35

*Based on an oil equivalent production rate of 50 bbl per day, an oil temperature rise from 85 F to 145 F, using 100 ft of ¾ in. finned tubing and 1 in. circulating lines.

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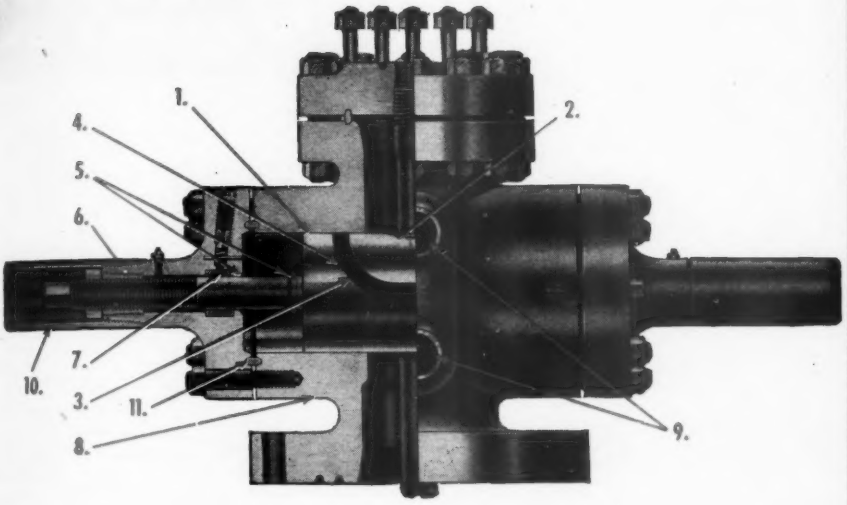

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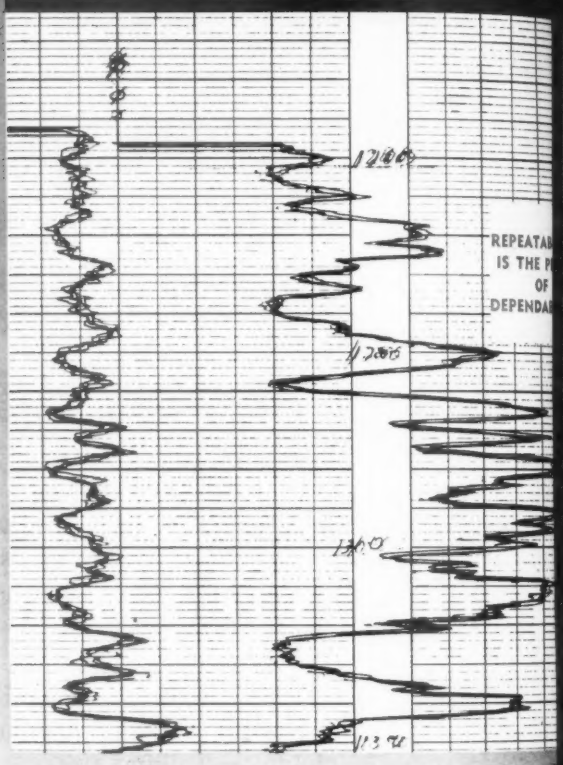

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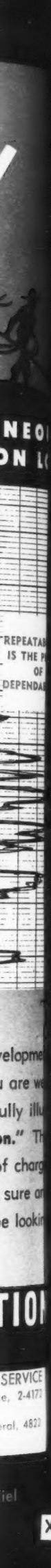

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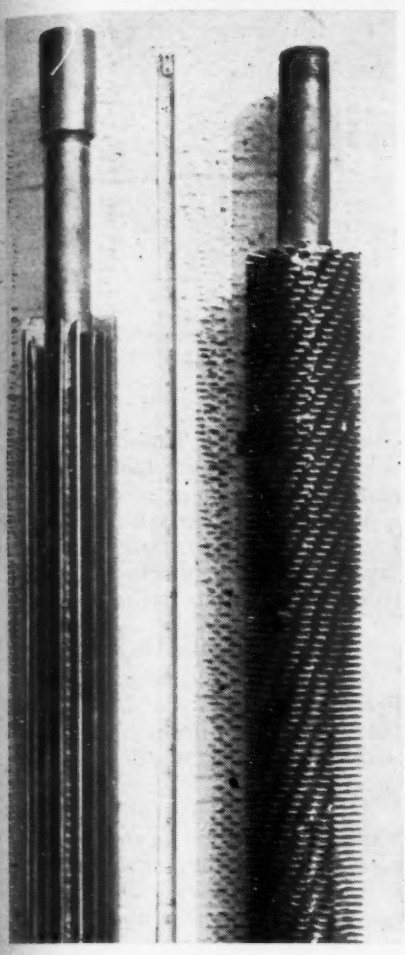

FIG. 6.

of net production and 15 bbl per day water cut or a 50 bbl per day oil equivalent in terms of heat load, it was determined that 20,000 Btu per hour would be required to raise the temperature 60 F and 40,000 Btu per hour would be available to heat the producing formation. It was also determined that 57,500 Btu per hour would be lost to the earth. On this basis an industrial type gas-fired heater of 175,000 Btu per hour input rating was selected.

Fig. 4 shows the plan layout of the heater and circulating pump and Fig. 5 is a photograph of a typical installation. Six-foot stroke hydraulic pumping units are used to pump the wells. These require approximately 2 hp, so 3-hp motors were selected to operate both the hydraulic pump for the well pumping unit and the centrifugal pump for the hot water circulation. This combination resulted in reduced electrical installation cost and provided all the flexibility required.

Fig. 6 shows two types of finned tubing used down the hole. Each has proved effective.

The cost of operating heater and pump is approximately $1.35 per day.

The increased production of approximately 8 bbl per day per well pays out each heater installation in less than 5 months. * * *

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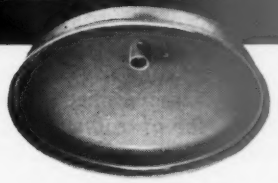

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Second of a Series

Lateral Drain Hole Drilling

Both surveying and lining at laterals are deemed important steps in successful application of the techniques

H. JOHN EASTMAN

IN the early part of 1951 a demand arose for surveys of lateral drain holes with both drift and direction desired. Unit which recorded angle and direction from vertical to horizontal already had been developed and it was found that this older type multiple shot instrument could be reduced in length and powered with short flashlight cells. A 90 deg angle unit was constructed so it could be shortened about 2 in. An extremely short barrel was manufactured with a bronze guide welded onto the bottom bull plug to assist in entering the mouth of the drain hole.

A flexible joint at the top of the barrel was spring-operated to stab the barrel in the lateral when no whipstock was used in drilling. Some of the first barrels made were too long to successfully negotiate the short bend where the drain hole left the main bore. Finally a barrel less than four feet long was developed and has been successfully used.

In many instances the barrel was made up on the resilient curved pipe directly so the instrument would enter the lateral. Whenever drain hole tools employing a whipstock were used for drilling the laterals, an articulated duraluminum section was interposed between the barrel and flexible drill pipe. Thus the instrument compass was removed from the magnetic influence of the flexible drill pipe and accurate magnetic readings were obtained. Many successful surveys have been made with this equipment. Recently an angle unit has been developed which will give directional readings from 0 to 140 deg drift (50 deg above horizontal).

Usually readings are taken at one-foot or five-foot intervals as the instrument is withdrawn from the lateral. A timing mechanism in the instrument synchronized with a chronometer at the surface indicates the readings to apply to each depth at which a record is taken.

Surveys have been made on many laterals, especially those drilled in California since 1951. They have assisted operators in the evaluation of drain hole drilling and its application to the producers specific needs. As a result service companies have been guided to the redesign of their tools to make them drill laterals more nearly as desired by the operator.

A study of these surveys gives a remarkable accurate picture of the mechanical functioning of drain hole drilling tools and has made available valuable data that has led to their improvement. As further advances are made in this type of high-angled drilling and as holes penetrate further from the main bore, surveys will become more essential.

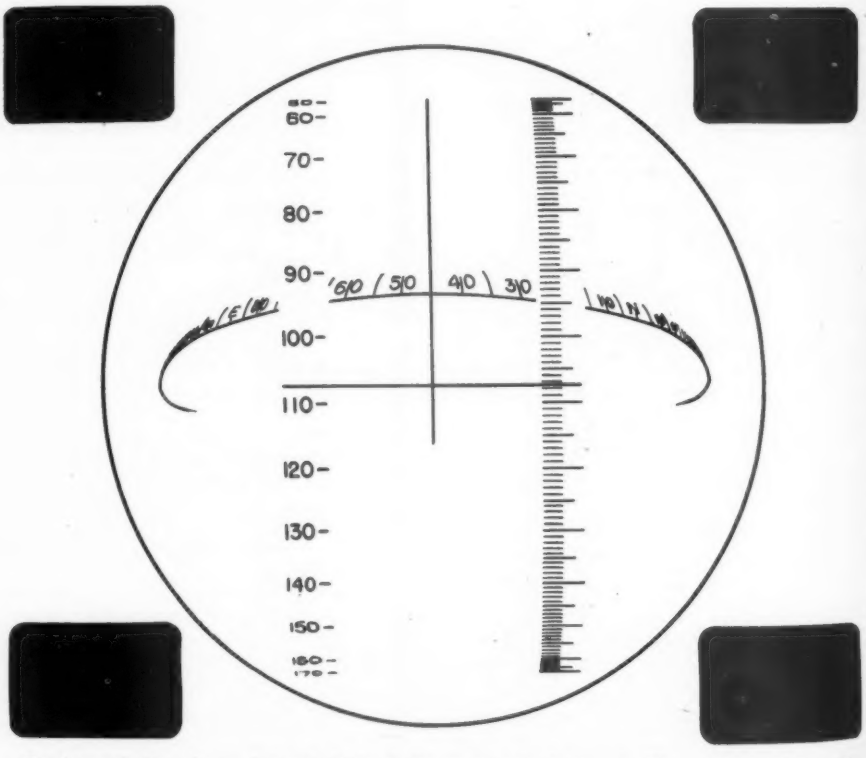
In many cases the knowledge of the course of the laterals will be important to the operator in whose well they are drilled. Drain holes dug in wells near lease lines must be surveyed to assure that they do not trespass upon an adjoining lease. Knowledge of the course of laterals near faults is needed and in steeply dipping sands, too great a depth penetration is liable to make the drain hole penetrate into water sands. Accurate directional surveys will assure that this has not occurred.

Drainhole Liners

Although Lee suggested the use of liners or other means of keeping drain holes open after drilling, he did not develop a technique for casing the laterals.

Although holes drilled with his equipment were left open and it was concluded that they stayed open, it is probable that they soon were filled and prevented the flow of oil from the ends of the laterals.

Most of the drain holes drilled in areas outside of California have not



Section of film from lateral drain hole survey instrument. The picture shows the lateral drain to be N 45 deg E at a drift of 107 deg 30 ft from vertical 9 or 17 deg 30 ft above horizontal. Readings are taken at desired intervals to show complete course of lateral.

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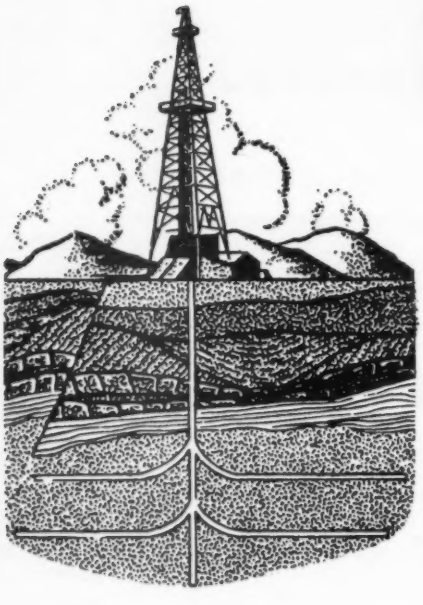

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6⅝" and 7"	5½"	4¼"	4¾"
8⅝" to 12¼"	7"	4¼"	6¼"

These drilled *HIGH ANGLE HOLES* may be produced either open or lined. Can be surveyed and/or logged. Particularly adaptable as *controlled* high angle directional drilling in areas of low pressure, low permeability, fractured limestone, fractured shale, chalks, tight sands, all of which add up to *increased formation contact* to increase production with *less acute decline curves* and a definite tie-in with secondary recovery, water flooding and injection techniques.

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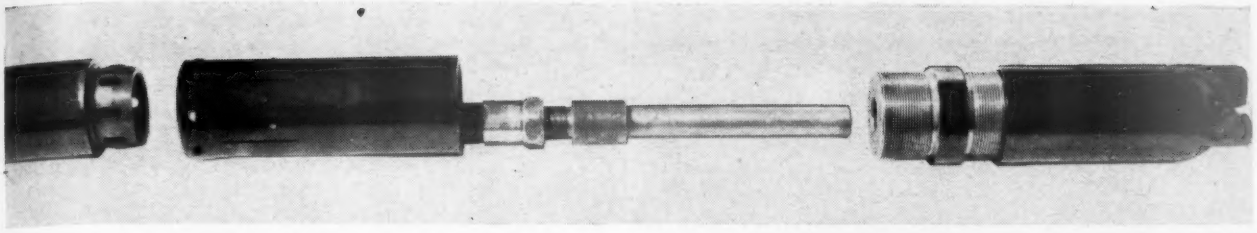

Bottom end of Eastman liner showing circulating shoe at right. Hose, sliding connection (center) are attached to pipe on which liner is lowered into lateral. Hose, connection, and shoe give circulation to bottom to assist in setting liner.

been lined; in fact, some treated with acid and hydraulically-fractured have not been cleaned out after treatment.

Recently the demand arose for a means to protect the laterals and assure that they carried oil to the main bore. As far as is known no positive means has been used to gravel-pack a drain hole completely from the extremity to the main bore to date. Whenever the main bore was flow-packed every attempt was made to flow gravel into the lateral but obviously the distant ends were not completely filled. The only practical method for doing this would have been to make a flexible tool to run the curved hole and flow-pack the lateral as the tool was withdrawn.

Today there are a number of types of liners that are run into drain holes. Sections of slotted liner are cut with lobes at short intervals to make them flexible. The outer section of some of these liners are prepacked with gravel. When running, a circulating shoe is attached to the bottom of the liner by means of a removable hose. Thus the drain hole is cleaned out as the liner is lowered into it. The liner is left in the lateral by a releasing sub. The circulation hose is attached to the flexible pipe and is withdrawn with it.

One type of liner is gravel-packed between the slotted pipe and a central oil-soluble hose. The hose is used to hold the gravel in place and to give circulation to bottom as the liner is being set. The hose is disintegrated by the oil in a few weeks, permitting oil to flow through the liner.

A liner of simple construction is being used effectively in the Wilmington and Torrance, California fields. Lengths of 2-in. slotted liner are prepacked with ¼-inch gravel to 4-inch OD, the gravel held in place with open steel mesh. Sections of this liner are joined to form a continuous pipe at least 5 ft shorter than the drain hole. A funnel shaped adapter of drillable metal is made up on the top of the liner.

The liner is lowered into the well and the adapter seats in the mouth of the drain hole. After all drain holes have been lined in this manner and excess liner milled off, a conventional slotted or prepacked liner is set in the main bore.

The adapter prevents the mouth of the drain hole from caving and maintains the effectiveness of the drain holes. The liner is easily run into the lateral due to its flexibility. When a whipstock is not used to drill the drain holes the end of the liner must be bent or a simple fluid-operated knuckle joint placed on the end to facilitate entry. * *

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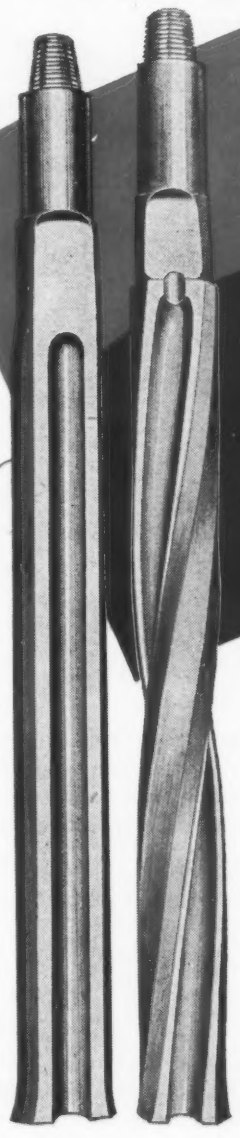

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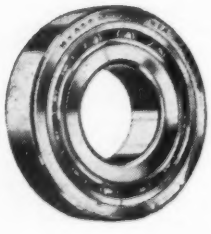

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TEN MILLION BARRELS in a STRATIGRAPHIC TRAP

Guijarral Hills field extension is a major 1954 addition to California oil reserve

JOHN KILKENNY

IMAGINATION coupled with a thorough basic knowledge of the mechanics of deposition and the geological history of the area is responsible for the 1954 discovery of production from the Leda sand in Spieler area of the Guijarral Hills field.

The extension was discovered by the Union Oil Company—Spieler No. 27-26. Completed January 24, 1954, flowing 1186 bbl per day of 36.8 deg oil, 5.1 per cent cut, through a 30/64 in. bean with 550 lb tubing pressure. The well later produced as high as 1256 bbl per day. It has now choked back gradually to 300 bbl per day. Production is coming from the Leda sand from the intervals 8810-8832 ft and 8838-8853- ft.

There are now 17 producing wells in this area with an average daily production of approximately 4600 bbl per day. The proven productive area encompasses about 460 acres.

The downdip limits of the field have been well defined to the east and northeast from the results of Union Oil Company's Bell 2 and Los Nietos Company's Guijarral Service 78-22. The former well, drilled as a straight hole, encountered the oil-water interface at the top of the sand at 8,853 ft (or —8,340 ft). This well was subsequently plugged back after penetrating the entire sand body and redrilled to the south where it was completed from 82 ft of Leda sand as a good well.

Los Nietos-Guijarral Service 78-22, drilled as a northerly outpost near the southeast corner of section 22-20S/16E, although structurally high enough, found the Leda sand pinched out and was abandoned. The updip limits of this part of the field have not been accurately determined although it is known that the Leda sand pinches out updip before reaching the Robert S. Lytle, Opr., 68-28 well in section 28-20S/16E.

Standard Oil Company's 354-27, near the center of section 27, is the highest well in the field to-date. This well logged 235 ft of Leda zone and also established the presence of a gas cap. It was necessary to complete the well from the sand zone to bring the gas-oil ratio down to a comparable point with the other producers in the field.

Productive Area May Be Large

It is conceivable that the Leda sand may extend updip a considerable distance into the west half of section 27 and that there may be a large gas reserve present. Los Nietos-Guijarral Service 38-22, located one-half mile northeast of the Standard 354-27 well, has encountered a very thin tight section of the Leda and produced a small amount of gas on a formation test.

The total extent of the Spieler area may be over 640 acres, but there will probably not be any more drilling in the eastern part of the field in the near future as Standard Oil Company owns all of section 27 in fee.

Development has shown that the Spieler area in actually a northerly extension of the Leda sand pool of the Guijarral Hills Oil field. The reader is referred to an article by G. W. Hunter entitled "Guijarral Hills Oil Field" in Summary of Operations, California Oil Fields, Vol. 37, No. 1, for details of the main field.

Old Structure Still Showing New Life

The Guijarral Hills field is situated on the southeasterly plunging Coalinga anticline which is famous for its numerous stratigraphic accumulations. The most noted of these are the old East Coalinga field which produces from the Temblor; the East Coalinga Eocene pool which produces from the Gatchell sand; and the Guijarral Hills field, the most southeasterly, which produces from the Leda sand (lower Miocene).

This latter accumulation was discovered in 1948 by the Barnsdall Oil Company. Production is controlled by the wedging out of the Leda sand across the axis of the Coalinga anticline.

The reason for the failure to find the Spieler area in the normal course of development of the Guijarral Hills field is an interesting one. Wells drilled along the common line of section 34 and 35 found less and less sand to the north accompanied by a decrease in structural position. A projection of this trend tended to eliminate the possibility of production in sections 26 and 27 due to lack of sand and low structural position.

Robert Sumpf, consulting geologist, reasoned that the line of maximum buildup of the Leda sand bar might be arcuate and swing north into section 26, roughly paralleling the Gatchell sand shoreline, and buildup high enough to be above the oil-water interface.

On this premise the Union Oil Company leased section 26-20S/16E from Hans R. Sumpf, Robert Sumpf, and the Helm Company and drilled the Spieler discovery well. Recent development has shown that the line of maximum buildup of the Leda sand is

The Author

John E. Kilkenny has been active in the discovery and development of the Spieler area of the Guijarral Hills field. He is chief geologist, Pacific coast division, for Union Oil Company which he joined in 1951. He was associated with the discovery of the Tejon oil field while employed by Chancellor Canfield Midway Oil Company as chief geologist.

Kilkenny was graduated from the University of California in 1935 with an AB degree in geology. He worked alternately for The Texas Company, Olson's Scouting Service, and the Superior Oil Company. He had considerable experience at various capacities on a geophysical crew, as a scout, and later as assistant geologist for Superior Oil Company.

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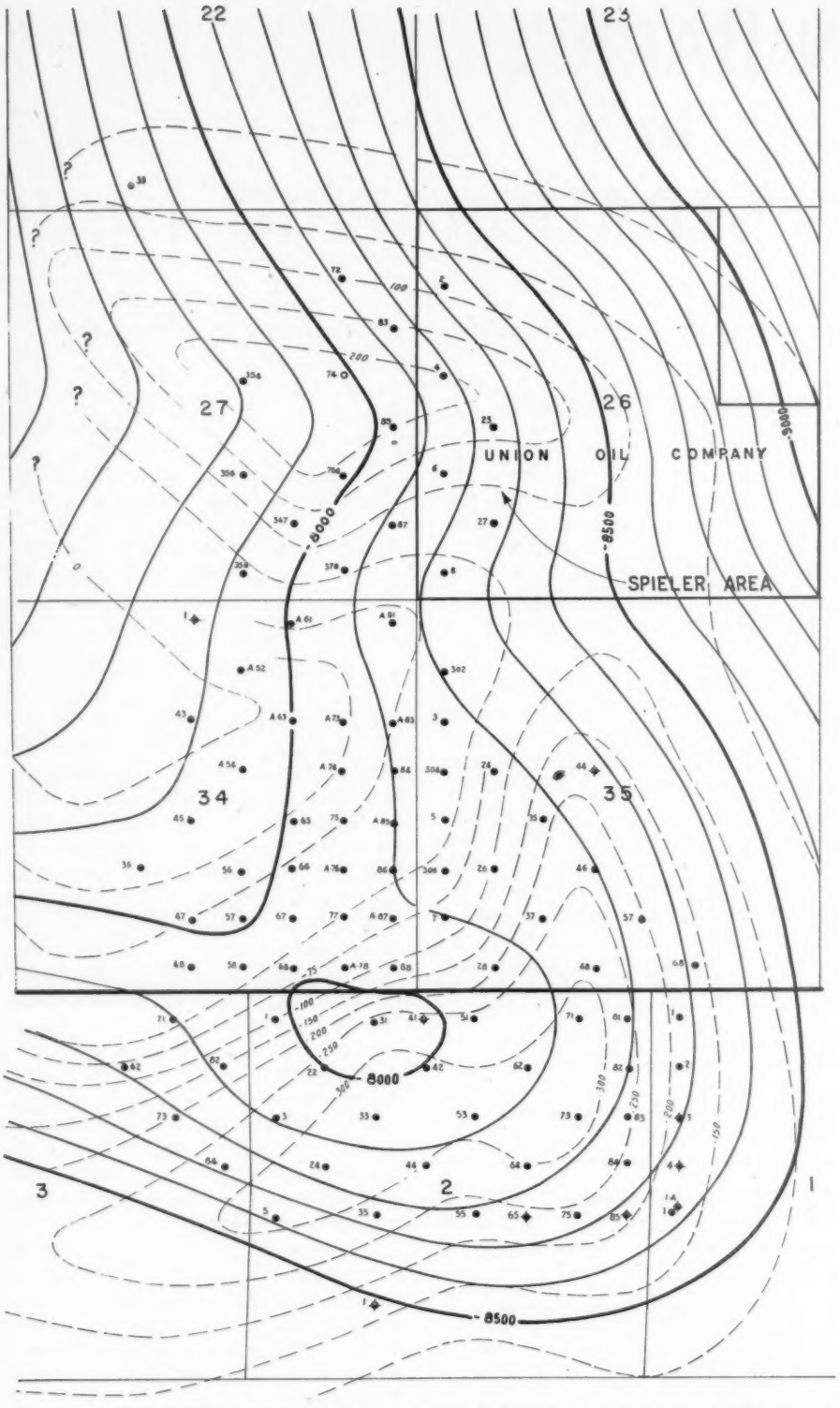

FIG. 1. Guijarral Hills oil fields Spieler area contours top Leda sand. Isopachs Leda sand.

even more arcuate than predicted and that it takes the form of a spit, trending almost east-west in section 27-20S/16E.

Stratigraphy

The Leda sand falls at the base of the Miocene section as used in California. Within the field it is overlain by the Leda shale (100 ft ±) in thickness and underlain by the Tumey shale of Oligocene age. Where the Leda sand is absent the interval between Leda shale and Tumey is represented by a thin glauconitic grit.

Neither unit thins appreciably with the expansion of the Leda sand. Strangely enough the buildup of the Leda sand seems to be compensated for by a thinning of the "Vaqueros section" above the Leda shale. The glauconitic grit at the Leda shale-Tumey shale contact is a good marker and can be carried southerly along the west side of the San Joaquin valley as far as the Belgian anticline.

In the Spieler area the Leda sand varies from 0 to 235 ft in thickness. It is massive with very few shale interbeds. On the average, permeabilities and porosities are better than in the rest of the field and a higher per acre-ft recovery may be expected.

Unlike the main Guijarral Hills field, there is no Allison sand production in the Spieler area except where the two areas overlap. This is due, in part, to the fact that the Allison is poorly developed or absent where the maximum buildup of the Leda takes place, and it is also structurally low.

Development of the Allison pool extended up to the edge of the Spieler area and a slight bowing of the Allison contours in Standard Oil Company wells in section 27 reflects the Leda sand buildup in this area.

Operations Relatively Simple So Far

The field so far has been developed on a 20-acre spacing pattern. No water trouble has been experienced to-date. Drilling is easy in the Spieler area and it is not uncommon for wells to see the sand in 20 days (average depth 8,800 ft). Average completion is 26 days.

Performance of the wells in the Spieler area to-date indicates that 10,000,000 bbl of oil have been added to the Guijarral Hills field and that this extension ranks as one of the most important additions to California's oil reserves in 1954.

Discovery of the Spieler area once again demonstrates the prolific nature of the Coalinga anticline, which has been one of the main focal points for oil accumulation in the San Joaquin valley. * * *

Gas In Mexico

Natural gas production in northeastern Mexico is confined principally to an area along the Rio Grande River, some 20 or 30 miles wide at the Gulf of Mexico and stretching inland about 125 miles. Prior to 1938, oil companies drilled 56 wells in the area and found 3 structures having commercial gas production. Since that time exploratory activity has been carried on chiefly by a government corporation, Petroleos Mexicanos, or Pemex. In 1944, Pemex drilled its first well, a wildcat, and found commercial gas at 6000 ft. This well was the deepest well ever drilled using wood as a fuel. Since 1944, Pemex has discovered several other gas fields.

However, gas production is not yet adequate for the markets of northeastern Mexico. For many years The Monterey area has used imported gas.

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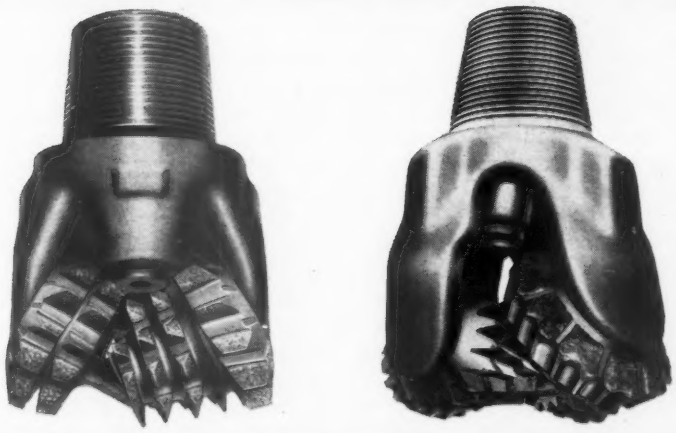

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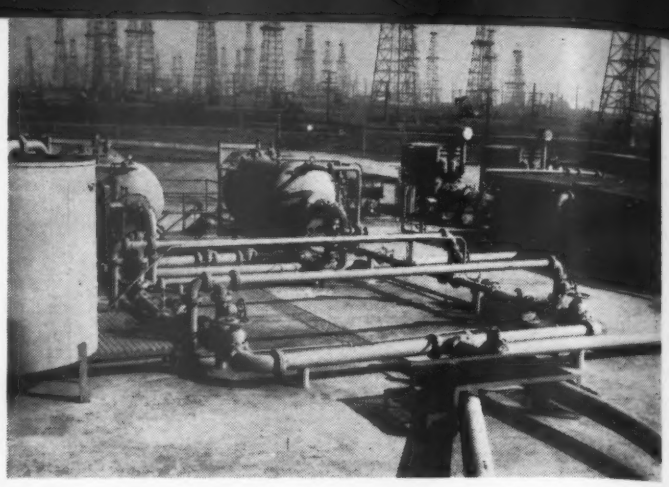

Views of salt water storage and treating plant. Note use of plastic and plastic-covered pipe at right.

P 111.61

FIRST MAJOR CALIFORNIA WATER FLOOD

JERRY STUMM*

THE first major California water flood project was recently put into operation at the Dominguez Oil Field. The flood is a cooperative venture of the Union Oil Company of California, Dominguez Oil Fields Company and Shell Oil Company, working as individual companies rather than through unitization of the area. Union Oil Company is the operator of the injection system.

The field is located in the Inglewood fault trend, in the west central portion of the Los Angeles Basin, about 12 miles south of the City of Los Angeles. Discovered by Union Oil Company in 1923, it is ranked among California's first ten. During its development, between 1924 and 1940, approximately 400 active wells were drilled and the field has produced in excess of 200,000,000 barrels of oil.

Structurally, the Dominguez oil field is a faulted anticline, divided into 4 principal fault blocks, comprising the east, east-central, west-central and west. Stratigraphically the field is divided into 8 productive zones. Zones 1-5 inclusive are of Pliocene age, 6-8 and below are Miocene, comprising a total of approximately 4000 ft of producing interval.

The flood area is in the east central block, on the Hellman and Reyes leases, comprising 118 acres on which there are 16 producing wells and 17 injection wells. Four of the injection wells are common boundary line, input wells. The stratigraphic interval is in the first zone, from the electric log AA to AM, which is the base of the second (Callender) shale. Thickness of the flood interval is 350 gross ft with an average of 190 net ft of sand. Average oil gravity is 31 deg and average oil viscosity at reservoir temperature is 2.3 cp. Average porosity of the sand is 28 per cent and average permeability is 250 md. The average well depth is 4230 ft.

Water injection was started July 1, 1954, into 4 wells, and by July 31 all 17 injection wells were on injection. At that time all input wells took water at a vacuum, with the reservoir pressure of 50 to 300 psi. As of November 1, a few of the wells were starting to show a slight pressure.

The total net oil production rate, from all producing wells in this water flood project, prior to starting the injection, was approximately 700 BD, and the initial total produced water rate was approximately 700 BD. Salt water is being injected at the rate of 10,000 BD and it is calculated that an increased rate of oil production will be observed early in 1955. Presently the water is run through the low pressure injection system (250 psi pump pressure), with most of the wells taking water at a vacuum at the well head. When it becomes necessary, the high pressure system will be used for water injection (2000 psi pump pressure).

The source of injection water is the composite produced field salt water. This water is first run through an iodine extraction plant and then is passed through two (400 sq ft each) leaf-type pressure filters, using diatomaceous earth as the filtering medium.

Raw water storage consists of a 5000-bbl capacity reservoir of gunite construction. Filtered water storage consists of a 600 bbl capacity, reinforced concrete tank. Water is put into the injection lines by two centrifugal, single stage pumps, with a capacity of 10,000 BD each at 300 psi. The high pressure pumps, to be used when required, consist of 5 vertical triplex units with a capacity of 2500 BD each at 2000 psi. All injection lines are cement-lined, with plastic and plastic-coated lines being used in the water filter plant. The rate of each injection well is controlled by a positive-bore flow bean. Orifice type water meters are located at each injection well head, and at locations for master meters.

At the inception of the project, the three companies involved agreed to complete the system so that the producing wells were all located within the AA and AM electric log markers. Some wells were deepened, other plugged back, a few were abandoned and in some cases, new wells were drilled. The work on the Hellman property was done by the Union Oil Company. The work on the Reyes property was done by Shell Oil Company. The Union Oil Company and the Dominguez Oil Fields Company have a working interest in both properties while Shell's working interest is limited to the Reyes property. As the flood progresses on the cooperative venture, each operator will realize yield only from the wells located on the property in which he has a working interest, and in direct ratio to that working interest.

It is expected, if this water flood is successful, that the project will be expanded to include other leases and productive zones of the Dominguez oil field. Such an expansion will naturally require more salt water than can be produced within the field. It is logical that such additional salt water as may be required will be obtained from the Pacific Ocean a few miles away. * *

*Pacific Coast editor.

EXCLUSIVE

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CALIFORNIA TIDELANDS— WHAT IS THEIR FUTURE?

Offshore oil reservoirs may yield two billion plus barrels of vitally needed west coast oil

HOMER STEINY and J. B. STUMM

WITH the steadily declining number of California oil discoveries geologic attention has naturally begun to look for other horizons and a longing eye has been cast towards the Pacific Ocean. This oceanward look is not new to Californians, in fact to them the expression "go west" was cliche as early as 1895, as by then the Summerland oil field, in Santa Barbara County was already a producer from beneath the bottom of the ocean.

This was long before the oil business commended geologic consultation. This novel method so prominent at Summerland, however, showed a pattern as definite as that of Columbus and Lindberg in Atlantic crossings. So, in recent years, when it was hypothesized that additional oil could be found under the ocean, as at Long Beach and Huntington Beach, no problem presented itself in the development of the area.

The tidelands of the California coast have oil under them just as the highland has oil under it, and under exactly parallel conditions. One of the prerequisites of an oil field is that it be underlain by a source rock. Oil fields will be found where the geologic section includes a strata of this organic rock, and nowhere else.

In California this source rock was the highly organic shale, generally laid down in the ocean in the middle Miocene time. This Miocene touches the present outlines of California in at least three spots north of Monterey Bay, but its great invasion occurs below Monterey Bay, inland as far as the Sierra Nevada Mountains, and to the south as far as the Orange-San Diego County line.

At this point the Miocene generated shales move sharply out to sea, and in a southerly direction, and are not found again on existing land until they return at a point near Magdelena Bay in Baja California. It is for this reason that it can be prophesied that San Diego County will never produce oil as the Pliocene sands lie directly on Eocene sediments and the desired Miocene is absent. Almost identical conditions exist at Humboldt Bay, in northern California. Here, the Pliocene sands rest directly on Franciscan metamorphics and the necessary organic sediments are absent.

According to the geological map of California the encroachment of the organic sediments occurs at the following general areas:

1. A small area at Cape Mendocino, in Humboldt County.

2. A small area at Port Arena, in Mendocino County.

3. The Drakes Bay area in Marin County.

4. The Davenport area in Marin County.

5. The long, solid, coastal area extending from Morro Bay, in San Louis Obispo County, on the north, to the southern boundary of this great organic sea at Orange-San Diego County line.

The amount of oil that might be expected to yield from this nearly 800 miles of coastal perimiter can best be estimated by first, listing the possible fields that may exist along its route, and then, by multiplying that number by the barrel expectancy of an average California oil field, such as Elwood. A reasonable potential may be arrived at through these factors.

The offshore fields which may be reasonably expected to exist are:

1. **Cape Mendocino**
2. **Point Arena**
3. **Drakes Bay**
4. **Davenport**
5. **Coon Creek**
6. **Surf**
7. **Point Conception**
8. **Refugio Beach**
9. **Hope Ranch**
10. **Santa Barbara**

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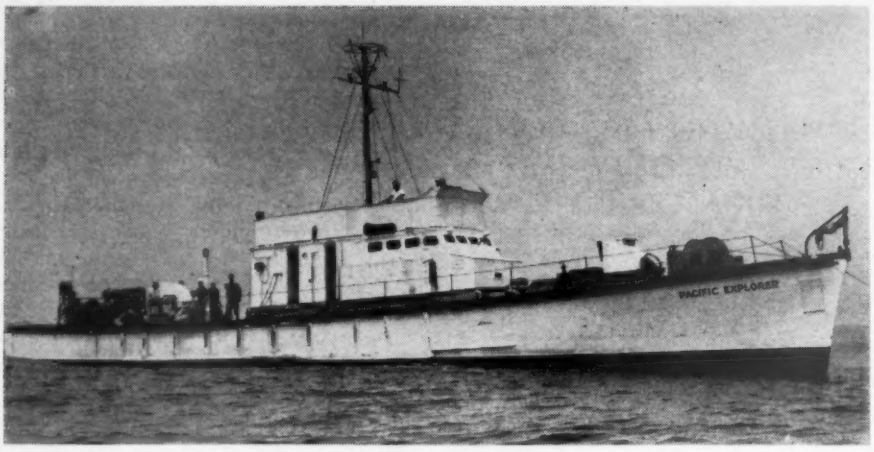

Pacific Explorer, "flagship" for one of the joint operations.

11. Loon Point
12. Carpinteria
13. Rincon
14. Point Magu
15. Point Dume
16. Santa Monica
17. Venice
18. Redondo
19. Seal Beach

A review of this list, as it is a forecast, might indicate that it should properly have a discount factor. None is used, however, as there are perhaps several fields that are not seen at this time.

Elwood oil field has to date produced approximately 90,000,000 bbl of oil. It is estimated that it will produce an additional 18,500,000 bbl during the remainder of its productive life. This is an average California oil field. It produces from lower Miocene and Sespe rocks.

Some of the offshore fields mentioned could conceivably produce from additional strata, particularly Pliocene. Therefore the figure of 108,500,000 bbl is felt to be conservative for each field. Multiplying this by the 19 potential fields listed gives a grand total of 2,061,500,000 bbl of California tidelands oil, approximately one half the entire existing, estimated California reserve.

The admission of California into the Union as the 31st State, September 9, 1850, carried with it the fixed westerly boundary of the state as 3 miles out into the Pacific Ocean. Development of this tidal area, under the jurisdiction of the State of California, continued without question for over 70 years. Grants were made to cities and leases made to oil companies, all in good faith when, out of a clear sky, during the Roosevelt administration in 1945, the Federal Government began proceedings which ultimately gained

A 200-ft geyser erupts from the ocean off Long Beach from a 90-lb black powder charge set off by a seismic survey crew... survey boat hovers nearby.

federal ownership of these offshore lands. This unprecedented act was ratified by the United States Supreme Court in a split decision handed down on June 23, 1947.

The controversy over the tidelands ownership temporarily halted actual offshore prospecting in California. In all such cases, however, farsighted people could visualize an eventual settlement.

At that time the seismograph was developing an excellent oceanic technology and the use of this equipment was contemplated by several oil companies who realized that the knowledge obtained therefrom would have them in readiness at such time as the tidelands dispute would be settled and actual development begun.

Accordingly in 1946, Texas Company began seismic work in the ocean in the area from San Louis Obispo County to San Diego County. Their example was soon followed by Honolulu Oil Company which conducted similar operations in the same area. The initiative shown by men of these two corporations slowly created a desire for similar projects by others.

Several unanticipated factors crept in and upon the application of the oil companies to proper state authorities for permission to conduct further these harmless surveys, these obstructions came to the surface. Primarily they were the complaints that seismograph explosions would contaminate the

The Authors

Stumm Steiny

Homer Steiny is a true grandson of the California gold rush as his grandparents came to California soon after, and because of, the discovery of gold there. He was born and raised in Stockton, California, and is a graduate of Stanford University. He was continuously employed in the Geological department of the Tide Water Associated Oil Company and its predecessor, the Associated Oil Company, for over 35 years, 1918-1953 inclusive. He has been a member of the American Association of Petroleum Geologists since 1925 and has served on many of its committees.

He was district representative from the Pacific coast section and was president of the Pacific coast section, 1951-1952. He is a member of the Geological Society of America and of the California Academy of Sciences. He is also a member of the Western Oil and Gas Association and has served on its Oil Information committee and its Wildcat committee. He is now a practicing consulting engineer residing in Los Angeles.

Jerry Stumm is a native of the west and attended Occidental College where he studied journalism. In 1941 he joined the Army Air Force and was a medium bomber pilot, participating in considerable combat activity in the Mediterranean area. Following World War II he was employed in various California oil fields as roustabout and roughneck. In 1949 he joined the service division of Byron Jackson Company and participated in development work of jet-perforating equipment. In 1950 he was transferred to the oil tool division of that firm and was active in the development, sales and service of various types of rotary drilling and production tools. He also directed advertising and sales promotional programs for Byron Jackson prior to joining the editorial staff of *The Petroleum Engineer* in May, 1954.

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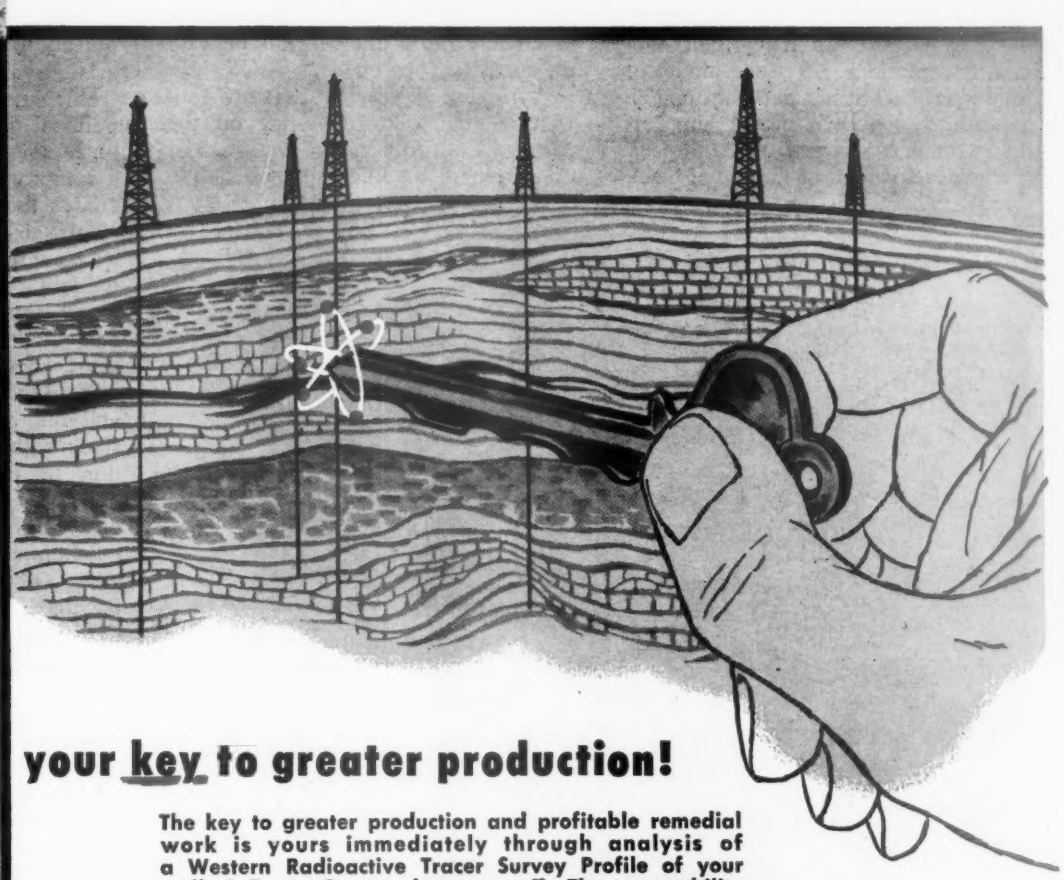

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beaches with dead fish and kelp. Secondarily they were the complaints that the economic loss resulting from the destruction of fish and kelp beds would appreciably effect welfare of those industries involved in the recovery of fish and kelp along the Pacific seaboard.

Ironically, one opposing but enterprising fisherman, contracted to salvage all the dead fish that the shooting parties gave up from their submarine explosions. After one month of following the seismic party around in his fishing boat had netted him less than $100 in fish he gave up the project.

The development of the use of black powder as a substitute for dynamite has practically eliminated the destruction of fish and the release of loose kelp that might contaminate the beaches. This slow burning black powder is detonated a few feet below the surface of the water and the results are almost as satisfactory as those obtained by exploding dynamite on the ocean floor. The destruction of fish is negligible and effect on kelp beds is practically nil as they lie far beneath the surface of the ocean.

During a 17-year period, up until 1945, actual kelp harvesting off the coast of California netted the State of California in royalties about $25,000. Oil royalties, either paid or owed to the State of California, now total more than $87,000,000. This royalty has come principally from oil and gas leases on 14,072 acres of coastal tide and submerged lands and 8135 acres of inland tide and submerged lands. There are over 2,000,000 acres of such lands, owned by the State of California, waiting to be exploited.

Suffice it to say, 90 per cent of the objections to conducting seismic operations along the Pacific Coast stem from ignorance and the balance is political nonsense. To overcome these objections the State authorities offered a compromise, the details of which included the cooperative operation of a single seismograph party, supplying its resulting records to all who cared to join. This compromise, with its many shortcomings, was agreed to, and carried out for approximately a year, commencing in October 1948. At various times 18 operators were in and out of this project. Those who stuck with the project from its inception to its conclusion include The Hancock Oil Company, Humble Oil and Refining Company, Continental Oil Company, Honolulu Oil Company, Ohio Oil Company, E. W. Pauley, Richfield Oil Corporation, Shell Oil Company, Standard Oil Company of California, Western Gulf Oil Company and Wilshire Oil Company.

The United Geophysical Company, under the able guidance of Herbert Hoover, Jr., contracted the actual seismic work and reported directly to an operations committee. The unwieldly size of the membership in this project and the many irrelevent debates and viewpoints that arose finally brought it to a conclusion.

Projects having the same objectives were soon organized and succeeded during the following years, in surveying in great detail, most of the areas listed earlier in this article. A very successful group was assembled by Standard of California, Humble and General Petroleum. This group included a samler to take samples off the ocean floor and make microscopic, paleontologic examinations of these samples right on board ship.

An almost parallel organization was formed by the Union Oil Company of California, Shell and Continental. These two group have now concluded their operations and have, no doubt, gathered all of the information that can be had from the floor of the coastal ocean by present methods.

Somewhat later Richfield began a seismic survey and was followed by Western Gulf. The latter, in its very intensive operation, employed two seismic crews as well as two crews to take ocean floor samples for paleon-

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The magnet elements are made of the most advanced magnetic alloy which is magnetized as an assembly and specially treated to insure axial lines of force at the pole faces. The power of the Bowen Kingston Fishing Magnet is concentrated at its engaging end. This avoids any attraction with the walls of the casing and assures unrestrained lowering into the well.

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tologic examination. United Geophysical Company and Western Geophysical Company were both very active in these operations.

Currently, Richfield is conducting seismic operations from the north Ventura County boundary southward to the Mexican border. At the same time, Standard of California is surveying the area between Point Estero in San Louis Obispo County to Point Dume in Los Angeles County.

It can readily be seen that a staggering amount of data has been compiled from the seismic work conducted by the various oil companies operating in this area. This could not have been done without the expenditure of an enormous amount of money, running into many millions of dollars. For the most part this preliminary work is completed. The next step, before these oil companies can realize any return from this investment, will be to make additional huge outlays of risk capital to do exploratory drilling.

Still other hurdles lie in the way of realization of development of the California tidelands. Provisions of the state law presently limit development to comparatively few acres of the 2,000,000 odd submerged acres of land owned by the state. California is empowered to grant leases for drilling only in those areas where it can be determined that "drainage" from existing fields is being suffered or threatened. Another provision of the state law declares that drilling platforms or other structures are not permitted to be built offshore except on filled land.

An example of the cost of construction of a land-filled island is supplied by Monterey Oil Company which, in partnership with Texas Company, completed the first offshore oil well ever drilled on a man-made island, Monterey-Texas State No. 3. The island is approximately 8000 ft seaward from the city of Seal Beach in the relatively shallow depth of 45 ft of water. The island measures only 75 ft in diameter but construction was in excess of $500,000. The well was completed October 5, 1954, flowing 300 bbl of 26.4 gravity oil per day. The construction of the island along with the drilling of the well, and all other expenses totalled well over $1,000,000.

Other costly delays and inconveniences which the oil companies must anticipate are those involving jurisdiction claims made by the various counties, cities, and municipalities along the California coast. An excellent example of this is also provided by Monterey. A criminal action was brought against the company by the City of Seal Beach, involving the construction of the above mentioned island. The City of Seal Beach claimed violation of its drilling ordinace and building code. The case went all the way from the Superior Court of Orange County to the State Supreme Court where a decision was finally rendered, in October, 1953, that the City of Seal Beach had no jurisdiction over the tide and submerged lands owned by the State of California.

While this case may establish a precedent for future, it is reasonable to assume that many others will arise. This particular case was in litigation for over 14 months during which time the partially completed island had to be maintained against the forces of nature, at a cost of over $90,000.

It still remains for the State of California to approve legislation to set aside these hurdles. The state and people of California have everything to gain in the development of these coastal areas, as royalties will continue to be paid to the state at the same rate as the first $87,000,000 was paid. The Cunningham Committee was appointed for the purpose of drafting suitable legislation to this end and progress is being made. But not until such legislation is signed into law will the state of California and those oil companies, who had the foresight to prepare for tomorrow, be able to take full advantage of this two billion barrels of California oil. * * *

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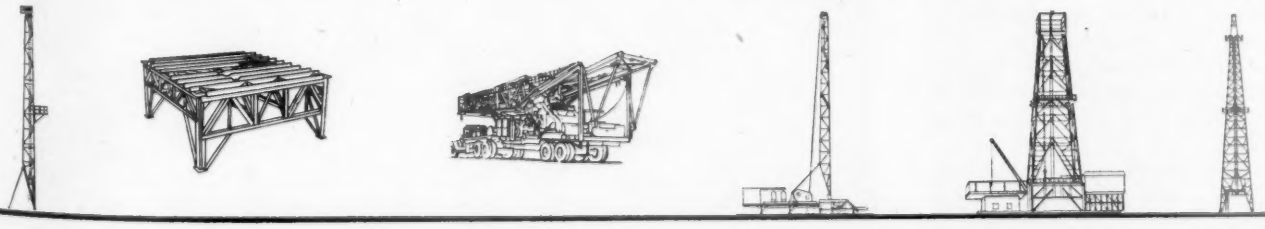

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How California Can Improve Its Productive Oil Potential

Responsibility for better recovery rests squarely on the shoulders of the engineers responsible for drilling, testing, cementing, and completion

FLORENT H. BAILLY

THE problem of obtaining a maximum yield from subsurface oil reservoirs is by no means wholly indigenous to California.

With its sharply decreasing rate of new discoveries, however, and decline in proven reserves, accompanied by an ever-increasing demand for petroleum products in its natural markets, California has been placed in the position of being a potential importer of crude rather than a traditional exporter.

Great strides are being made in the development of new processes for extracting products from hydrocarbons, when produced, and the exploratory tools being used for the discovery of possible subsurface traps and structures are keeping pace.

It is becoming more and more apparent to California engineers and geologists, however, that new tools must be found, and a greater application of engineering knowledge indulged in, to increase the yield of hydrocarbons from California reservoirs that have not been exploited and to review with greater care the bases for having condemned, as non-productive, other reservoirs penetrated and passed up during drilling.

These engineers are slowly awakening to the importance of extracting more and more information from the actual drilling operation in order to determine first, the presence of hydrocarbons in any formation and secondly, to ascertain the physical properties of the formations in order to determine the proper drilling measures to be employed to prevent a reduction of productivity potential and thirdly, to choose the completion tools and methods that will fulfill a design, tailored to the maximum fluid yield of the reservoir, as indicated by its physical properties.

The first and all-important objective in the drilling of a well is the recognition of the presence of hydrocarbons in the formation being drilled. Tools being used for this purpose, and coming into increasing use are:

1. Well site examination of well effluent; cuttings, mud, and gasses through improved, continuous recording instrumentation, and sampling techniques.
2. More complete analysis of cores from reservoir rock with special attention to the ability of these to yield fluids in terms of their physical properties, mineral composition, and type of fluids, under reservoir conditions of temperature and pressure.
3. More careful assembly and analysis of all information obtained from the drilling well for the interpretation of electric and gamma ray logs.

Having determined the existence of hydrocarbons in any zone, the second major problem that confronts the engineer is in the choice of drilling and testing techniques, and the proper selection and application of mechanical devices presently available to the engineer that will encourage maximum yield of the hydrocarbons from a specific reservoir.

EXCLUSIVE

The fundamental requirement for maximum yield is an optimum permeability for the formation to the fluid to be produced. The drilling program itself must be planned to avoid violation of this fundamental requirement, or else its purpose is defeated and may even contribute to delays in discoveries.

The drilling program first must include preventive measures. The use of techniques and tools that will prevent damage to formation (reduction of permeability) is imperative in order that the testing and completion techniques and tools will not be overburdened with remedial tasks prior to accomplishing their primary functions.

Secondly, the drilling program must include positive measures, the choice of tools to be used, in their proper sequence, to attain maximum efficiency in fluid recovery.

Drilling fluid laboratory

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Drilling Fluids

Drilling fluids retain a predominant position in damage preventing tools in the drilling program. Muds retain this priority because better drilling fluids have, in general, increased drilling rates and effected an over-all reduction in cost per foot.

The engineer's task becomes more difficult when a specific drilling fluid, though excellent for facilitating speed of drilling, may not be the best for the prevention of damage to formations. The conventional test for these properties of drilling fluids are not adequate to determine their degree of damage to potentially productive formations.

For reliable data the tests on these muds should be carried out under the environments of temperature, pressure, and actual formation conditions existing where the mud is to be employed. Laboratory work indicates great divergence in the presence of the chemical variables found in the connate fluids of the rock or their mineral composition. Laboratory tests indicate that some muds generally considered the most protective, will behave completely in reverse under certain environmental conditions in the wells.

In one case the actual result was an insoluble plastic-like material that effectively sealed any and all capillaries. Tests under actual well conditions, alone brought this to light. More and more emphasis must be given the selection of drilling fluids that will properly protect formations.

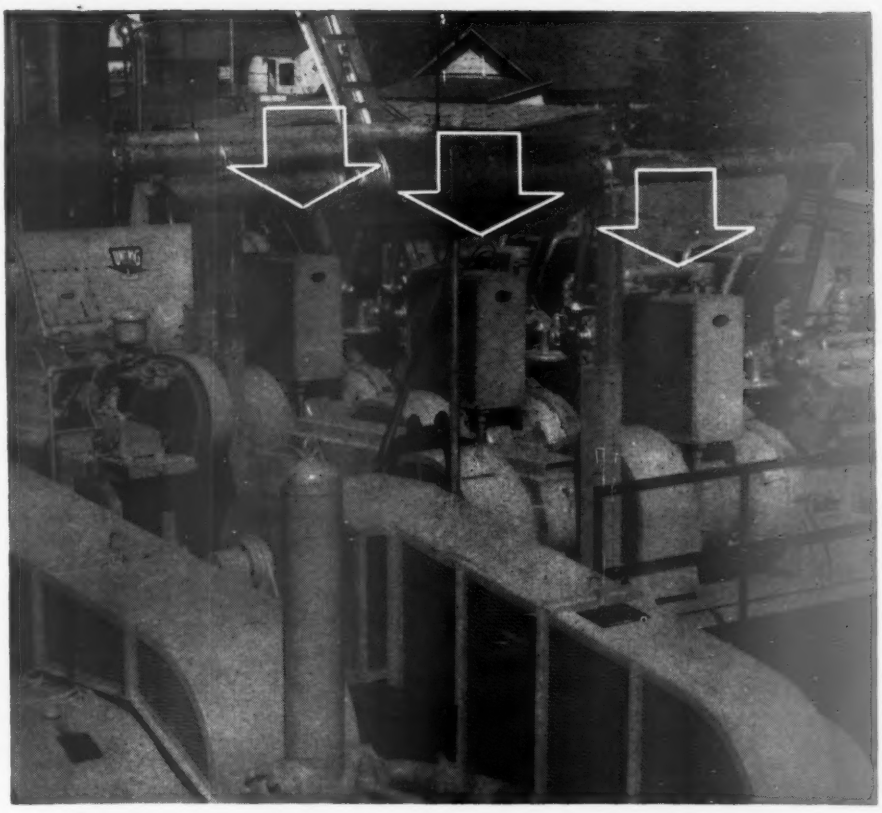
The most protective drilling fluid may mask other characteristics of the formation from the engineer and geologist. If this is the case, there are other techniques available to the engineer to compensate for this defect, without sacrificing the protective value of the mud.

The primary requirement of maintaining the permeability of the formation without reduction cannot be sacrificed. Logging companies are keeping pace in developing alternate methods so that pertinent information can be obtained.

Formation Testing

Open hole formation testing tools continue to be effective evaluation tools. Experience, however, has taught that very few formation tests are conclusive unless they are positive, and formation fluids have been recovered, or knowledge of the rock in the interval tested would indicate that it could not be expected to yield any fluid, regardless of pressure differentials.

There are other cases, however, where results would appear to be conclusive but are not. Too few realize that a maximum differential pressure



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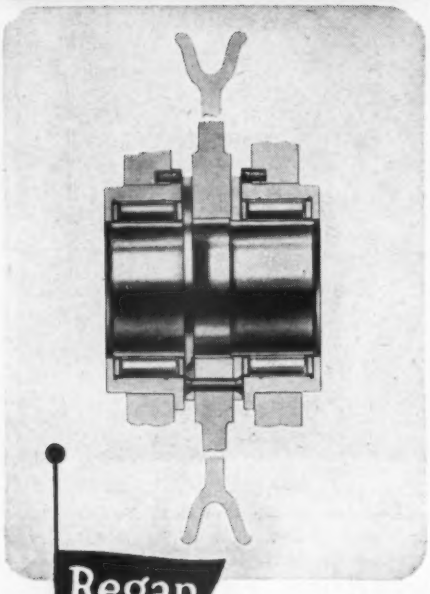

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The Author

Florent H. Bailly is head of Petroleum Engineering Associates and Oil Properties Consultants, Inc., and Litholog, Inc. A native of Venezuela, Bailly attended school at the California Institute of Technology, where he received a degree in engineering. He returned to Venezuela and was employed by the Pantepec Oil Company as a field engineer. Bailly was promoted progressively up the ladder until he was elected president in 1949. He resigned from that office in 1950. Besides being head of two concerns he is also active in oil exploration in the Western United States and Cuba.

across the face of sand does not induce maximum fluid yield.

Every hydraulic system has a critical pressure for its maximum throughput. A capillary system is no different except that its geometry is so erratic that if a critical pressure is reached, for the maximum surface of cross-sectional area, the remaining part of the system may continue to contribute at an increasing rate, plug back the other tributary capillaries and the net result would be a rapid drop in total volume of flow, with increased pressure. Hence, it is up to the engineer to know the physical properties of the reservoir rock in order to intelligently employ the formation tester.

In such cases where the hydrocarbons are suspected to be in a gaseous state in the formation, and the pressures and temperatures may be such as to indicate that the normally liquid hydrocarbons are also in the gaseous state, a sudden reduction of pressure across the face of the potentially productive reservoir, below the dew point of the hydrocarbon mixture, at that temperature, could cause retrograde condensation and saturate the formation immediately around the well bore with liquid hydrocarbons.

Relative permeability relations have indicated that gas flow may be completely prevented until the liquid saturation of the formation is reduced from 2 to 10 per cent depending upon the formation. In such cases, an unintelligent use of the formation tester would produce but poor to negative results. What is worse, liquid desaturation is difficult and might not be accomplished with any great degree of success unless new formations were opened and not damaged through fluid block, in a sidetracked hole.

The Casing Program

The oil string, its running and cementing, deserve the specific attention of the engineer. Its design, to withstand tension and other pressures, is easy. But it must be remembered that the oil string may be placed opposite many feet of potentially productive formation. It will be either gun or jet perforated for production, but first it will be run and cemented.

Wall scratchers and centeralizers are used to assure bond of cement to formation, and even distribution of cement around the pipe. These excellent devices, however, unless used intelligently, and placed properly in the oil string, may do far more harm than the good that was intended and, in some instances, completely destroy the effect of the preventive care of the past days and weeks.

All the care taken to secure an impermeable filter cake to protect the formation is voided if the scratchers are improperly positioned. Prior to a cement job the drilling fluid may be at its poorest.

If the filter cake is removed under this condition, the cake that is substituted is certainly not of the caliber of that removed, and the protective value of the original is destroyed. Does the subsequent filter cake offer a better medium for a bond with the cement that is to follow? This is very doubtful.

The cement job itself offers one of the greatest inducers to formation damage, and can further void all the care taken to prevent damage up to that point. The cement loses filtrate to the formation. Will this filtrate damage the formation by reducing its permeability? This can only be determined through actual tests under reservoir conditions of temperature and pressure. The engineer will know how to design the cement column accordingly and keep cement away from formations that may be damaged thereby.

Completion Program

The completion program must have as its primary objective the increase of formation permeability. In other words, the effective radius of the well in the productive horizon must be increased.

If every step in the drilling and testing program has prevented reduction in permeability, up to completion, then every step in the completion technique should be engineered to increase its permeability.

The tools available to the engineer depend upon the formation involved. The techniques must be tailored to the formation and its fluids. There are many tools available for this purpose. Sand fracking has this effect, but must be used with caution, depending on

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STOP!!-AN' WHISPER TH' WORDS AH IS DYIN' T' HEAR!!
YO' MEAN THEM THRILLIN' WORDS 'BOUT HOW WE JOHNSTONS DO TH' FINEST TESTIN' JOB, BECUZ O' TH' HYDRAULIC TESTER, THAT PREVENTS SHOCK T' FOR-MAY-SHUN, PIPE, AN' INSTRUMENTS!!
NO!!-THOSE EVEN MORE THRILLIN' WORDS, 'BOUT--
'BOUT HOW TH' HYDRAULIC TESTER GIVES YO' POSITIVE OPER-AYSHUN EV'RY TIME?-
PSST!!-AH THINKS SHE MEANS---
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-AN' YO'!!
-AN' YO'!!
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reservoir fluid and rock conditions.

Acidizing in limestone can attain the objective. Gun perforating and jet perforating have their place. If the environment of the well is not propitious to production, however, jet perforation may merely extend the damaging environment deeper into the formation, and extend the radius of damage.

Lateral holes may also be drilled to increase the effective diameter of the well bore, but these again must be drilled in an environment that will be propitious to maximum production, or else damage is increased and no positive or remedial effect can be expected.

The perforation pattern, or lateral hole placement, should be engineered in terms of the natural permeability of the rock formation. A relative permeability profile for the formation will determine the variable effective radii values that will assure equal flow per unit pressure drop across unit surface face of sand or reservoir rock.

Conclusion

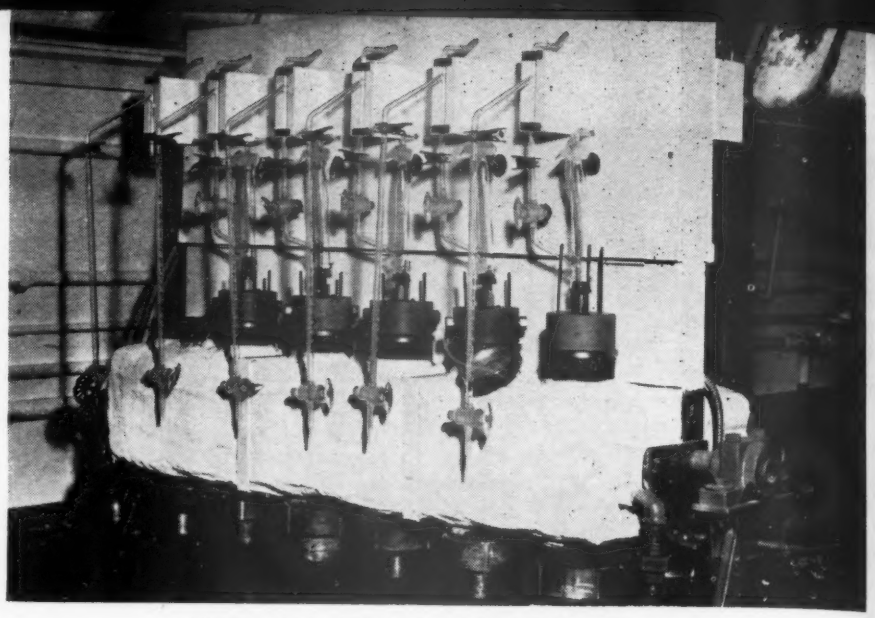
The California petroleum engineer is today challenged to use all the accumulation of data, techniques that have developed, and the great array of tools and methods that are placed at his disposal.

This array of data, of methods, and tools, if wrongly used, can do more damage than good. The tools can only be used effectively if the engineer has an intimate knowledge of the reservoir formation that permits him to design the drilling, testing, and completion program to the formation. Only then may he expect it to yield its contents efficiently, with the greatest conservation of energy.

The drilling contractor is doing his part in the reduction of drilling costs. The service companies are doing their share in presenting an array of drilling fluids. Information and data securing services are contributing by systematic recording and tabulation of drilling data, formation composition, and well effluent analysis. Tool manufacturers furnish a diversified array of implements to assist the engineer in his programming for a specific well.

It is squarely up to the drilling, testing, cementing, and completion engineer to intelligently use the tools and information available, and to plan and design his program properly.

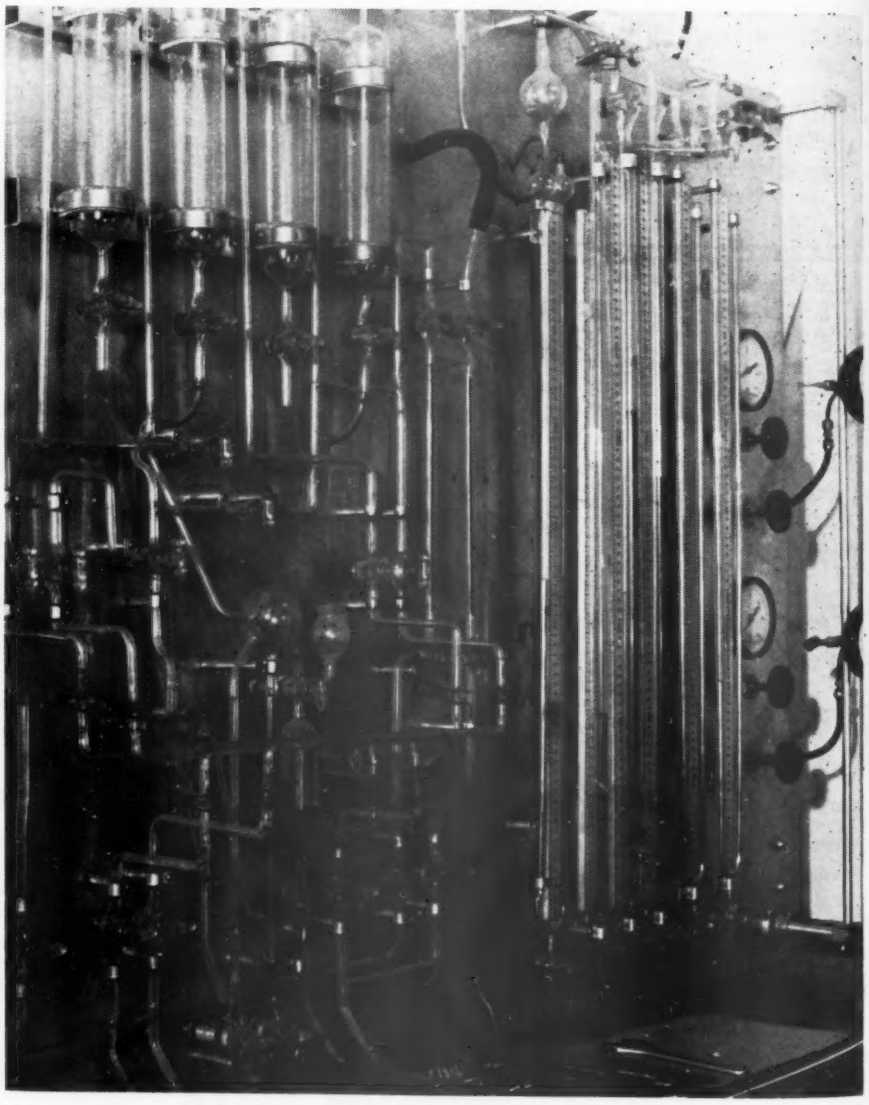
The California petroleum engineer is accepting the challenge, and more and more will join the ranks who will, and can, insist on a well program that will give a potentially productive horizon the best chance to yield its fluid and protect such a potentially productive horizon from the ever-present, and threatening, red pencil of the purchasing agent, whose appreciation of values is controlled necessarily by hindsight.



Temperature controlled water flooding apparatus

The petroleum engineer must earn the right to insist on, by a record of performance in the intelligent use of, all the instrumentation, techniques, and tools which are at his disposal.

California engineers will see that no potentially productive horizon is condemned, and thereby give greater assurance that oil production and discoveries will be maintained. * * *



Relative permeability apparatus oil and gas flow

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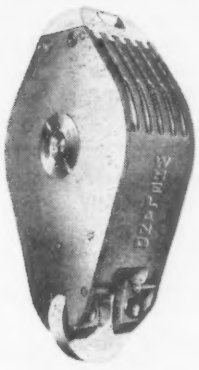

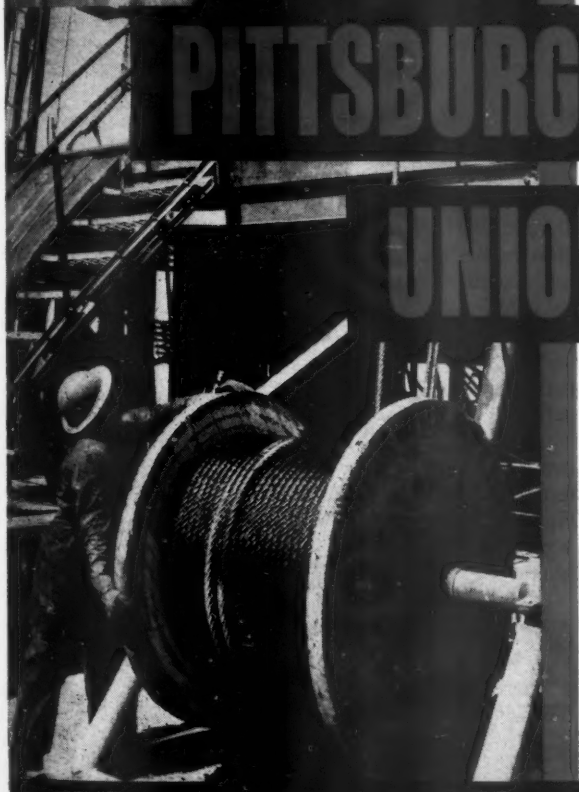

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Methods Improvement

third of a series

Improving Rotary Rig Operations

Efficiency in moving is vital. Time carelessness here can mean the loss of most of the profit from a drilling venture

WILSON J. BENTLEY*

YOUR rotary rig is just a heap of junk metal unless it is engaged in drilling a hole in the ground! When is the rig not drilling? These non-drilling periods include trip-making, other operational delays, delays or shut-downs for maintenance, stacked rigs between holes, and rig-moving time. The analysis of these common happenings is an important activity in this increasingly cost-conscious era.

The first two articles of this series described a method of observation and analysis which lends itself well to activities connected with rotary rig operations. Studies of the activities of the various personnel during normal operations were described in the second article of the series. The author has found that it is more difficult to observe, record, and analyze the teardown, move, and rig-up activities than to study the crew activities during normal operations. An increase in the number of people working on a job (at the same time) increases the difficulty of making a study with the objective of making the job easier, quicker, simpler and safer. But the expected rewards of such a study are likewise increased.

Drilling contractors need not be told that from the time they complete one well and get started on the next the money is all outgoing — and none incoming. Included in this outgoing expense is money expended for crew labor, for trucking expense, for bulldozer work, and (depending upon their method of depreciation) depreciation. In a number of instances the cost of transferring a rig to a new location determines whether or not a profit is made on drilling a well. These well-known facts strongly indicate that this element in the activities of the drilling contractor should be closely studied and analyzed.

The two previous articles on the subject of methods improvement in the oil industry (job design) described four important steps necessary to successful results in considering human work methods. The first step is to determine and record the current manner of performance. The second step consists of placing the information obtained in Step 1 in a form that will facilitate understanding and analysis. The third step is the analysis of the information that has been obtained and recorded. And the fourth step follows with the improved method resulting from this analysis.

The steps described have been followed in reference to moving portable rotary rigs. The entire operation of tearing down, transporting, and rigging up were observed and recorded. Observations were started when the first crew member, truck or bulldozer arrived at either the old or new location. The activities of each piece of moving equipment and crew member was described and timed until the rat hole was started. These activities were then plotted (to scale in relation to time) on graph paper. All activities were timed to the nearest minute. This resulted in a series of charts similar to Fig. 1. This type of chart presents a clear picture of the activities of each person and each piece of moving equipment in relation to time — and to each other. The author usually places an unbroken work period on one sheet whether it should be six, eight, or ten hours. With the information, shown in this manner, the operating personnel and the analyst can cooperate in analyzing the activities.

It is obvious that each rig will have its eccentricities, each location will have its particular problems, and that the weather will have its effect on the moving conditions. But a number of problems can be found that are common to most rig operations.

In this activity of rig moving, as in those described in the previous articles, non-productive time was not a premeditated act. The desire to get the job done is an established trademark of the toolpusher-driller-roughneck team. The causes of most of the practices considered to be inefficient appear to be the lack of pre-planning and the lack of "heads-up" supervision on the job.

For instance, how closely are the activities of the crew members supervised during the last 24 to 36 hours of completing work on a well? What is the crew doing while they are waiting for cement to set? What can they be doing in relation to maintenance or getting

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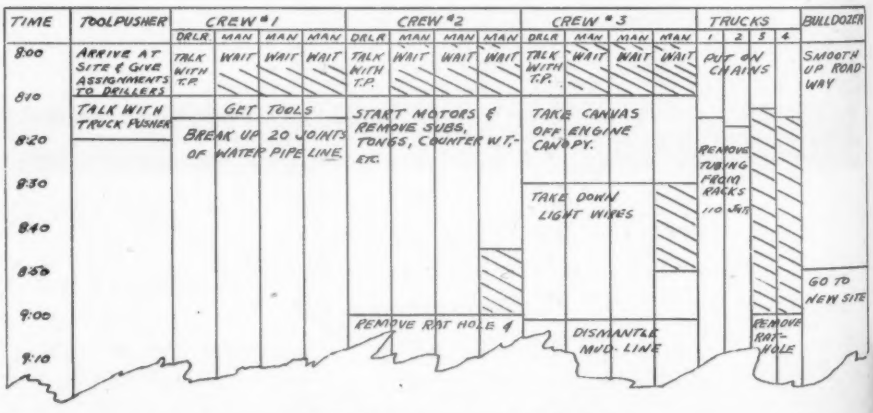

FIG. 1. From data given on activity data sheet, an Activity Chart is prepared by plotting activities in proportion to time consumed. Comparsion of individual efforts to overall operation is made easier by this chart. From such a graphic presentation, analysis can be made and improved methods designed.

*Associate professor, Industrial Engineering Management, Oklahoma A & M College.

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ready to tear down the rig? The answer to these questions may vary with the particular situation, but, nevertheless, here is a time period which seems to always be most conducive to man-hour waste. A common cause of rig dismantling delay is the time it takes to get the drill pipe and racks out of the way so that the mast can be lowered. What is the earliest time that the drill pipe can be removed? Again, the exact time may vary, but the point is, that the reason for delay should be recognized and the situation analyzed for a solution.

When should the rig be scrubbed down? This is another "pre-planning" decision that the toolpusher should make. Crews often spend 25 to 30 man-hours cleaning the rig. Then it gets spewed on while swabbing or pulling pipe. The cost of labor and materials, as a result of this rather common incident, will be a minimum of $70. Reason for the loss may well be the result of the absence of proper instructions.

The step by step information obtained and pictured by an activity chart such as the example, Fig. 1, will bring out many facts never before isolated so they could be studied. For instance, is it known in your company the expense of digging and boarding-up the average cellar? A cellar, 6 ft by 6 ft by 3 ft, in average ground requires about 12 man-hours of digging with shovels and picks. Boarding-up the sides consumes about 3 man-hours. Pre-sawed lumber and drayage will amount to about $40. On the average, cellars of this size are costing about $70 in labor and materials and drayage. If the drilling contractor knows this figure for his operations in any specified area he then has the information to guide him in making decisions as to possible alternatives. For instance, in some areas it is possible to contract drilling the celler with an earth auger. A direct true cost comparison can then be made between these two alternatives with a resulting decision based on fact.

A rigid exact time-value for each of the various operations involved in moving a rig is not considered practical. There appear to be too many elements affected by variable conditions to attempt this procedure. A set of approximate time-values can be obtained though. In other words, a fairly accurate set of time-value brackets for normal conditions can be obtained and used as a standard of comparison with actual performance. Such information would also be helpful in making moving cost estimates more accurate. These values will vary with the type and size of rig and, with type, size, and number of pieces of auxiliary equipment.

The most important part of moving a rig, though, is pre-move planning.

TABLE 1. Rig moving chart.

Bulldozer	New site crew	Pipe line crew	Rig crew	Trucks
		(Morning)		
Break ground for cellar crew. Break ground for ditch. Dig pits. Help finish—level site.	Prepare site Dig cellar. Get cellar bds. & matting bds. delivered.	Allowing one day for stringing or laying 1 mile of line—start crew accordingly.	Tear down rig. 2 men work under rig floor & remove all lines connected to rig. Driller & two men work largely on rig floor. Clear rig floor of all tools & equip.	1-gin truck dismantle pipe racks; stow equip. in specified carrying racks, i.e., jets, barrel, mouse hole, rat hole, pipe, spider elevators, boards, blks, swivels, steps, pumps, & deliver matting bds.
		(Afternoon)		
Dig pits & help level for matting boards	Wall up cellar. Level area. Measure distances & stake locations of equipment. Place & level matting boards.	Same as morning	2 men-drain & disconnect water pump, unhook jet lines. Help disassemble derrick. Unbolt substruct. Driller & 2 men unbolt A-frame & lower derrick. Unbolt motors & draw works. Help disassemble derrick. Spool drl. line. Prepare substructure for moving.	2-gin trucks 1-tandem truck Pick up & load equip. in carrying racks. Help lower derrick. Help separate derrick & deliver to new site. Help dismantle substructure & deliver.

Next in importance is active supervision by the toolpusher and drillers. Both the toolpusher and the drillers must have a clear concept of the sequence of operations necessary to the overall job to be done. (The decision as to whether to skid the rig, or not, and the method of calculating payment to the trucking firm are important considerations, but are not considered within the scope of this discussion).

The three most important considerations in getting started drilling in a new location are:

1. Having the new site prepared in time for the substructure to be placed with no delay,
2. Having a fuel supply available in time to raise the derrick, and
3. Having a supply of water available in time to start drilling in.

All other operations should be performed and timed with these three items in mind. Everyone knows that it is not practical to place the substructure in position until the matting boards are down. Yet, quite often, the substructure will arrive at the new well location before the matting boards do. Likewise, the mast will often arrive and be assembled before the substructure arrives at the new site. Costly delays invariably result.

Condition of the new well site will determine the relative time for assigning a driller and, at most, three men to finish-level the grounds, measure and designate the location for various pieces of equipment, and construct the cellar. Of course, previous to the assignment of this crew, would be the bulldozer work necessary.

If water pipe line is to be taken up, strung, and layed, the time for starting this crew must be calculated so that water will be delivered in quantity to start drilling in with no waiting. This is a problem of advance planning.

The three big jobs, then, are preparation of the new well site, the taking up and laying of the necessary pipe line, and the dismantling and rigging up of the rig itself. A general plan of operation can be outlined in chart form similar to Table 1. This chart indicates the sequence of operations; the approximate timing, and the assignment of jobs to the new site crew, the pipe line crew, the rig crew, the bulldozer, and the trucks.

There is a great deal of value in the outlining of the operations in this manner for the entire job of moving a rig. Then, particularly, for the benefit of the drillers a more detailed outline of the assigned duties of each of these crews (in the proper sequence again) should be made and provided them.

It is a definite advantage to everyone concerned with moving a rig, not only to have a knowledge of his own specific duties, but also, clear picture of the entire operation.

The toolpusher is the principle coordinator during a move. As the time necessary to accomplish the various elements of work will vary a great deal, he must have the entire situation in mind, and be on the site, so that he can vary the crew assignments according to the specific situation.

The driller must understand the general plan of operation and be able to take any of the assignments the toolpusher may make. The driller's primary job, particularly during a move, is supervision. This supervision consists of first, quickly seeing the most important job to be done; second, ascertaining the easiest and quickest way to do it; and, third, the best allocation of manpower. Then comes the secondary responsibility, and that is, getting in and helping do the job.

Several specific points of possible improvement have been discussed in the course of this article. Each company, and each crew even, will have its own spots of possible improvement. For instance, do you know when (in the sequence of rigging up) the the ditches

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are dug between pits and between the cellar and the pit? Usually this latter ditch is dug before the shale-shaker is put in place or the jet lines are installed. What happens? The truck, placing the shale shaker, gets stuck in the ditch with a resulting waste of time. Then, as a result of the truck driving over the ditch more man-hours are spent in digging the ditch out again. Another consideration about ditches — *how* are they dug? How many man-hours of roughneck labor is expended doing common labor work? Can you put a tooth on the bulldozer and have it break the surface for the diggers? This sometimes cuts the ditch digging time in half.

An important area to observe is the utilization of the trucks that are aiding in the move. Do they arrive at the site at the same time as the rig crews? If so, they probably have some idle time until the crews can make equipment available to them. Hourly cost of one truck is about the same as the hourly cost of a four man crew.

If you have wooden plank flooring for your rig floor do you know how many pieces there are and how long it takes to take up or lay the flooring? Some wooden rig floors have as many as 60 separate pieces. Do you know the monthly or annual cost of replacement of planks? The labor required to handle this flooring can be readily obtained from the type of study advocated in this series of articles. With the information asked for here one can easily make a decision about replacement of wooden flooring with metal.

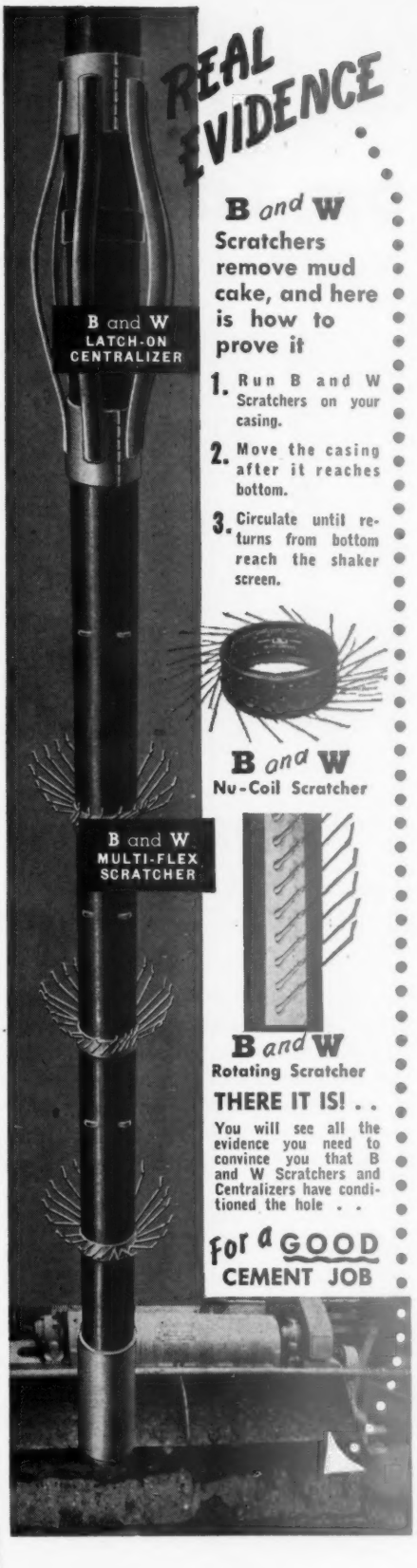
Exactly what are the time-taking jobs? This often is never really known until a job design study is made. One job element, often overlooked as a time-taker, is that of removing the derrick (after it has been lowered) from the substructure to the trucks. The two trucks at the base of the mast often have to adjust their winch holds three or more times before the mast clears the substructure. To obviate this waste motion it may only be necessary to place a roller under each side of the mast and have the lead truck edge the mast forward to a point where the two trucks need take only one hold. (Here again, the particular rig may or may not make this problem).

The order in which the equipment leaves the old well site is usually the order in which it arrives at the new well site. Yet the last item removed must be the first item down at the other site. And the second to last item removed must be the second item installed, etc. So the dispatching of loaded trucks from the old well site can be an important item. For instance, moving the mast in one piece often require two trucks — one going forward and one backing. The average speed that this arrangement can travel is usually not over 5 miles per hour. If these trucks are dispatched as soon as they are loaded the speed of all subsequent loads is limited to the speed of the mast load (as it is usually impossible to pass the two trucks carrying the mast). This crew at the new site will then be forced to wait until the trucks with the substructure arrives. By waiting 15 minutes while the substructure is loaded and then dispatching the truck carrying the substructure before the mast starts out a significant saving in time will normally result. Again, each situation must be analyzed rather than a constant rule-of-thumb applied. But the principal idea of studying the dispatching loads from the old well site is one which will reap dividends.

All of us have a tendency not to return tools to their proper place. If a driller does nothing else, he will practically make his salary by keeping track of tools used and seeing that they go back to a designated location. We also have the tendency to pick up objects and toss them temporarily out of the way. The author has seen one board picked up and tossed aside three times before it was finally put in a carrying rack.

There are many other areas of work that should be watched closely. For instance, the method of storing the drilling cable during a move. In one case, because of the lack of a suitable stand on which to put the reel, the job of getting the drilling line off the reel cost $18 in man-hours and truck waiting time. The method of stringing the drilling line on the traveling block and the crown block is another important feature. The author has observed time periods for this job varying from 5 minutes to 3 hours. Again, a "pat" solution cannot be offered due to differences in rigs, conditions, etc. That this is an important area to watch is the point here.

Job design is the design of the elements of a job for the most efficinet use of the man and the materials with which he works. Its objective is to design the job so that the easiest, quickest, safest, and simplest method of performance can be used. It is an aid in instructing, planning, and coordinating —which, basically, are the duties of managers and supervisors. It is a patient and intelligent search for facts to aid operating personnel in the performance of their functions. It must be understanding and human. It cannot be all mechanical. It must be a continuing activity and not a wrapped-up packaged affair. With this understanding of what it is and must be a higher standard of performance and productivity will result. * * *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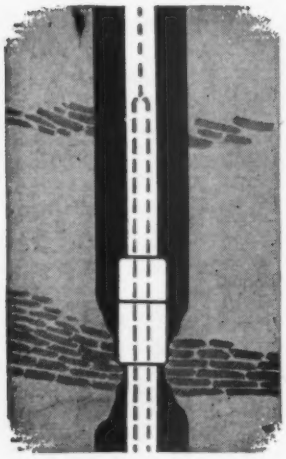

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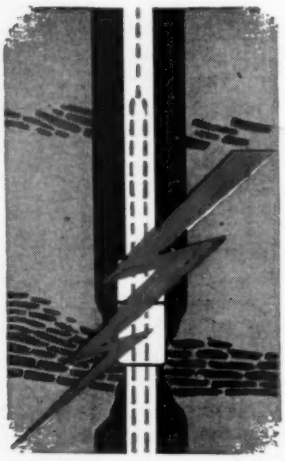

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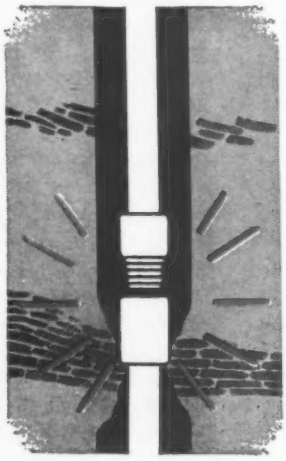
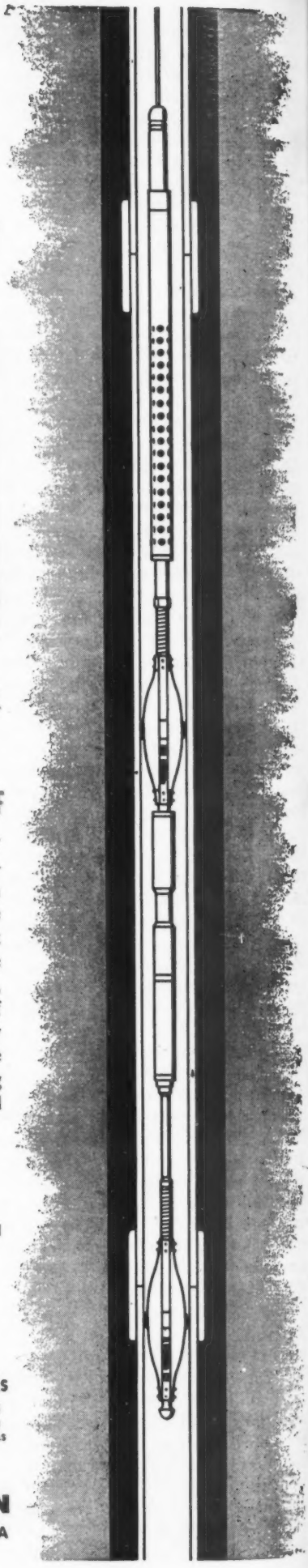


Back off recovers stuck drill pipe, drill collars, tubing or casing to permit further fishing operations.



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This tool accurately determines the lowest depth where *both stretch and torque* can be applied to the drill string. It locates the exact point where stuck drill pipe, drill collars, tubing or casing can be freed. Movements as small as *one-thousandth of an inch* are recorded electronically on a surface indicating panel. Since reverse torque is used to back off, pipe to be recovered must be free in torque as well as stretch. *The Dia-Log Free Point Indicator gives you this correct depth in a matter of minutes!*

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On the same electric conductor cable used for the Dia-Log Free Point Indicator, a "String Shot Back-Off" is run to the desired depth. Upon detonation, the "String Shot" delivers a sharp jar sufficient to start the unscrewing of the load-free joint. In thousands of successful runs, Dia-Log has recovered *millions* of feet of stuck pipe quickly and economically by employing this infallible combination. The "String Shot" also jars loose stuck tubing packers, frozen overshots, safety joints and stuck liners.

Wherever you are stuck -- Dia-Log Service is available

Dia-Log Service is available in all domestic oil fields. Wire, write or call any Dia-Log Company or Ford Alexander Corporation office for fast, dependable recovery of drill pipe.

OIL WELL ELECTRIC LINE SERVICES

Gulf Coast and Mid-Continent

THE DIA-LOG COMPANY

BOX 14103 — **HOUSTON, TEXAS**

Odessa, Texas
Hobbs, New Mexico
Farmington, New Mexico
Oklahoma City, Oklahoma
Healdton, Oklahoma
Great Bend, Kansas
New Iberia, Louisiana
Houma, Louisiana
Natchez, Mississippi
El Dorado, Arkansas
Corpus Christi, Texas
Kilgore, Texas

California and Rocky Mountains

THE FORD ALEXANDER CORPORATION

BOX 800 — **WHITTIER, CALIFORNIA**

Ventura, California
Taft, California

RIG LUBRICATION AND MAINTENANCE

Robert W. True*

THE service life of rig machinery is in direct proportion to maintenance practices. Drilling equipment operating under careless repair and lubrication methods will not successfully compete in present day competition.

Rig operators are continually striving for a greater percentage of "on bottom time" during the course of drilling the well, as well as increased penetration rates, and quicker rig-up-and-tear-down operations. Today's keen competition, higher operating expense, and increased investment have made it necessary for the rotary driller to push his effectiveness to an all time high.

Just what is this type of practice demanded of the equipment? Jet drilling, longer drill collar strings, greater depths, to mention a few, produce greater loads on all machinery involved. A 650-hp rig operating in Oklahoma was considered for 10,000-ft drilling 7 years ago, but it would be completely inadequate for this same drilling today. In 1950, 75 days was considered good time to drill to 10,000 ft, whereas only 35 days are needed at the present. Minimum power requirement is 850-hp.

Drill collar strings of 20,000 lb were considered adequate 4 years ago; in 1954, collar strings of 45,000 lb plus, are used frequently. Hook loads are approximately 25 per cent greater than in the past. With these conditions of heavy loading, every corrective measure must be undertaken to insure satisfactory service life from rig machinery.

Rig Maintenance vs Safety

From the standpoint of safety alone, one can see the effect of rig maintenance. No operator has been able to run a rig in poor condition for any extended length of time without having accidents that could be directly attributed to some poor maintenance practice. Listed below are actual accidents that can be definitely attributed to such causes:

ACCIDENT	END RESULT	IMPROPER MAINTENANCE PRACTICE
Pipe being pulled in V-door — catline parted.	Pipe struck employee on shoulder; lost time accident.	Faulty catline allowed to remain in service.
Employee slipped, fell into pump belts.	Hand caught in pulley, mangled left hand.	Pump guard not properly in place.
Cathead clutch engaged swing tongs toward drawworks.	Pinned floorman to drawworks, broke both legs above knees.	Cathead clutch in poor working condition.
Roughneck slipped on oily engine floor plates.	Fell off of platform; broke left ankle.	Oil allowed to accumulate on deck plates.

Many more such accidents could be listed, including those resulting in fatalities. It is impossible to expect a low accident rate if rig repairs and rig cleanliness practices are not demanded by the supervisors.

Rig Maintenance vs Repair Time

In all but a few extreme cases, the rig with a high repair down time percentage is one where a poor maintenance program is in effect. To illustrate this, we will examine rig efficiency reports from a light (425 hp) rig:

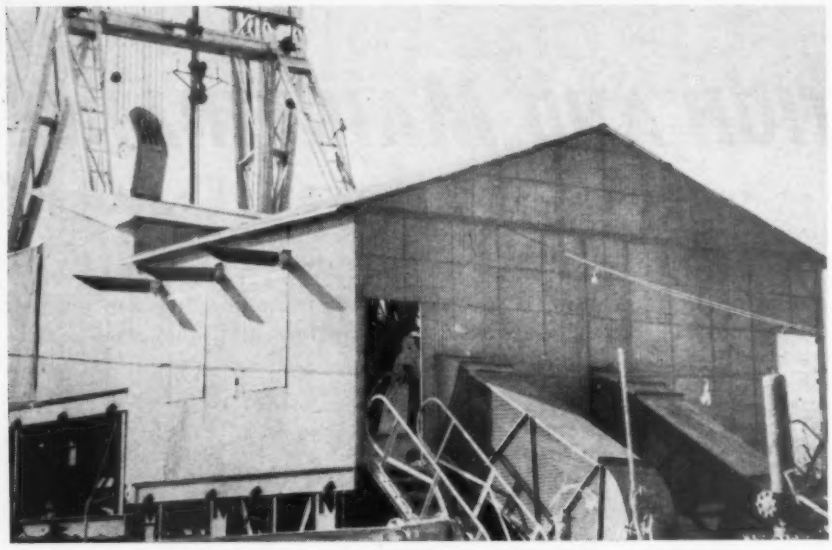
WELL NO. 1	Time/hr	Per cent
1. Total hours available for drilling	421.50	100.
2. Drilling time	301.50	71.53
3. Tripping time	54.50	12.93
4. Straight hole & lub.	34.25	8.12
5. Ream and wash	.50	.12
6. Repairs:	30.75	7.30
(a) Drawworks	8.25	1.96
(b) Pumps	2.75	.65
(c) Engines	1.	.24
(d) Drill collars & drill string	4.	.95
(e) Compound unit	—	.95
(f) Miscellaneous	14.75	3.50
WELL NO. 2		
1. Total hours available for drilling	509.	100.
2. Drilling time	293.25	57.61
3. Tripping time	44.25	8.69
4. Straight hole & Lub.	23.25	4.57
5. Ream and wash	2.50	.49
6. Repairs:	145.75	28.63
(a) Drawworks	3.50	.69
(b) Pumps	2.25	.44
(c) Engines	65.25	12.82
(d) Drill collars and drill string	1.25	.25
(e) Compound unit	4.	.78
(f) Miscellaneous	69.50	13.65

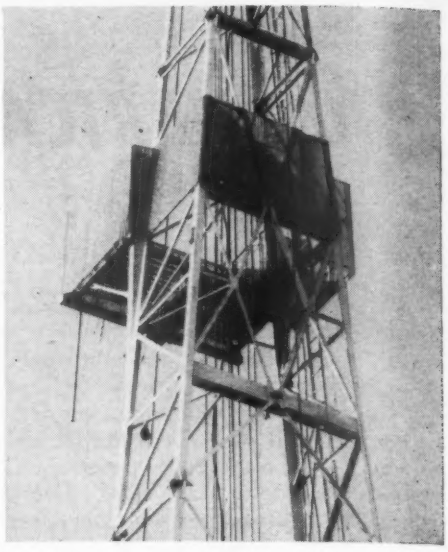
On well No. 1, drilling time was a high 71.53 per cent of the total time available for making hole. On well No. 2 only 57.61 per cent of the available time was spent on bottom. Immediately the analyst examines the record to find out why the large difference exists.

On well No. 1, repairs totaled 30.75 hr or 7.3 per cent; on well No. 2, repairs were 145 hr or 28.63 per cent. Engine and miscellaneous repairs (rotary table, crown block, traveling block, etc.) were 26.47 per cent. On this particular well No. 2, the master clutch was not working properly due to faulty adjustment, and during a trip, the driller was

An excellent provision for insuring clean oils is to provide an oil tank (A) to store lubricants. Forced draft blowers (B) enable engines to run cooler during hot summer months.

*Big Chief Drilling Company, Oklahoma City.





A clean, well kept engine shed provides protection against the weather for engines and machinery, shelter for the drilling crews.

Periodic inspection of wire lines to check for wear, enables crews to cut and move drilling line as needed for extended service life. Driller Traugott and Derrickman Reynolds are shown in the above picture using caliper to measure wireline wear.

unable to disengage the clutch, and hit the crown. The second major repair was due to improper maintenance and overloading drawworks engine No. 1. This engine had to be shopped and completely overhauled. Both of these mechanical failures are attributed to improper rig supervision and maintenance.

Rig Maintenance vs Profit

Referring again to the time summary of the above wells described; the effect of this type of service on profit income can be determined by comparing operating cost and rig time. The average daily operating cost for this rig on a group of 5 wells was $1168.00 per day or $48.66 per operating hour.

	Well No. 1	Well No. 2
Operating days	26	30
Total cost of well	$30,500.00	$35,200.00
Repair cost in hours down time	1,492.00	7,085.00
Profit or loss on operation	+2,840.00	—4,245.00

The effect of down time caused by faulty rig maintenance can prove disastrous to the rig runner in a short time. Note the comparison of these two 5000-ft wells. It will take two wells drilled as in No. 1 to offset the loss incurred in the drilling of No. 2.

The same emphasis should be placed on rig maintenance as is placed on "making hole." Hole must be drilled before profit can be made, but if the equipment is destroyed in doing so, no profit whatsoever will be realized. Therefore hole making and proper rig maintenance go hand in hand if profit is to be expected.

With today's prices for drilling providing only a narrow margin between profit and loss, only those rigs that can make greater amounts of hole in a shorter length of time can be used.

Balanced Lubricating and Maintenance Program

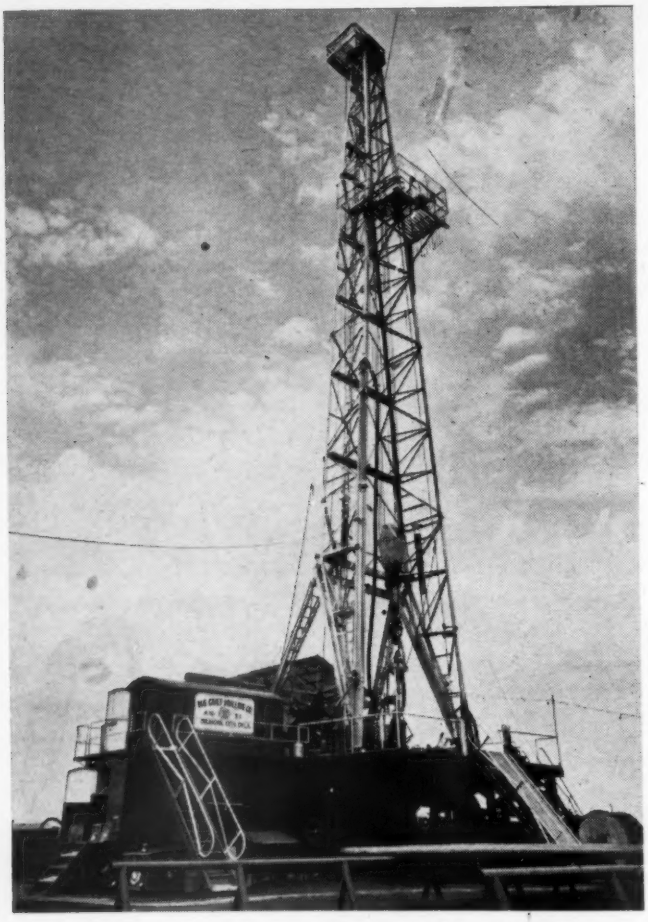
The backbone of any good maintenance and operational program on any drilling rig is training drilling crews in proper maintenance methods. This training and education must be provided for by the rig supervisors. Time should be allowed on the job so the crews can be given proper instructions. A man cannot be expected to do a good job if he isn't given the opportunity to learn how. Some methods whereby rig efficiency can be increased are:

1. *Discussing proper lubrication of rig parts in meeting on rigs.*
2. *Studying maintenance manuals to increase knowledge of proper lubricants and maintenance practices.*
3. *Discussing equipment and maintenance with factory representatives.*
4. *Keeping continuous records of oil changes, chain repairs, pump repairs, wire lines, engine overhauls, etc., to provide a check on the service of equipment.*
5. *Inspecting equipment periodically to determine amount of wear on parts. Many times minor repairs can save a major breakdown.*
6. *Providing rig operators the necessary equipment, oils, and repair parts, so the rig can be kept in proper working condition.*

Key to Correct Maintenance Practice

It is not the purpose of this article to set a hard and fast rule to follow in obtaining satisfactory rig service, but to show the effect of poor rig maintenance practice on profits; also to help the rig supervisor evaluate his past maintenance procedure and how it can be improved. The toolpusher should plan maintenance practice with his drillers

Merry Christmas



Clean walkways, ladders, and location, reducing falling hazards.

and crewmen; a practice that will be effective, timesaving, and complete, with a minimum amount of planned down time. In many cases, the supervisor only talks about maintenance and does not see that it is carried out. Equipment operating 24 hours a day must have proper care; one failure on the part of a crew member to do his job can produce sizable loss.

Since modern machinery is enclosed in suitable housing, the rig operator needs only to keep the proper clean oil in service to provide proper chain and bearing lubrication. The oil should be checked daily in order that foreign material can be discovered. Too often the supervisor is inclined to resist down time to make necessary oil changes, thus continuing the use of unfit lubrication fluids. Once foreign matter is imbedded in precision bearings, etc., the damage is already done and clean oil is then unable to insure satisfactory service. Filters and lubricating systems should be checked daily along with oil pumps to be sure they are operating satisfactorily.

It might be well to list common bearing failures so the operator can adjust his maintenance practices to offset them:

1. *Misalignment*
2. *Inadequate or unsuitable lubricating fluid*
3. *Faulty installation; defective sealing*
4. *Defective bearing material*

Once it is realized that a faulty bearing exists, it should be replaced as soon as possible, for the shaft is out of alignment, causing additional wear on all parts. One should be thorough in planning lubrication and maintenance operations, so it may be well to include these practices:

1. *Follow rig and equipment manufacturers' recommendations on types of oils, greases, filters, and certified repair parts to use. Examine lubricants before they are used, thus insuring against adding the wrong lubricant.*
2. *Provide time daily for drilling crews to check all lubricating systems and oils for cleanliness.*
3. *Examine periodically valves and gear power end of mud pumps, check mud valves and circulating lines, replace worn parts before the start of a well to eliminate additional down time.*
4. *Keep tool houses, engines, all machinery as clean as possible; don't allow waste oil and grease to accumulate, thus reducing fire hazards.*
5. *Operate blowout preventers daily while drilling; at at the completion of each well, tear down all equipment and clean thoroughly. Drilling mud is highly corrosive. Oil working parts so they will be ready for the next well.*
6. *Grease all suspension equipment (blocks, hook, swivel) daily. This is a good practice since these parts are exposed to the weather at all times.*
7. *Keep spare rig parts in clean tool houses or boxes so they can be immediately available when needed.*
8. *Examine derrick and rig substructures at regular intervals to discover loose bolts and pins. Check for weld fractures.*
9. *In most cases, standby equipment, such as electric plants, air compressors and standby mud pumps are used only in emergency. Therefore they are left idle for extended lengths of time. This equipment should be started and run for a short time daily to insure proper condition when needed.*
10. *Maintain a regulated engine maintenance program.*
    - *(a) Keep hourly service record on engines.*
    - *(b) Change oil and filters at designated intervals. This will vary with type of engine and geographic location.*
    - *(c) Have mechanic check engines at the end of each well or during the drilling of deep wells. Check for bearing and shaft wear.*
    - *(d) Examine cooling system for corrosion and rust, and analyze water to be used in cooling system, using chemicals if necessary to treat water.*

Rig crews can usually be judged by type of housekeeping practiced. A well maintained rig will have crews that are conscientious about the machinery, and are doing their utmost to complete a successful drilling program.

Summary

A sensible rig maintenance program cannot be realized on any equipment without the proper training. Drilling crews must be educated by supervisors before costly down time can be eliminated. They must be taught by specific examples the importance of proper lubrication and maintenance practices. They must be able to see the harmony that can exist between a well-planned practice and the "hole making" operations.

The importance of keeping the rig in proper working order 24 hrs a day cannot be over-emphasized. Down time caused by improper repair practices reduces the chance for a profit to be realized. A clean, well-kept rig where lubrication and rig repairs are properly and timely carried out, will produce a profit for the contractor at prices which cannot be matched by the haphazard or careless rig owner.

ROTARY TABLE

Harold A. Bohneberg*

THE rotary table is a device to rotate drill pipe in the hole and thus turn the bit. In addition, the rotary table must be capable of supporting the drill pipe, or a string of casing, when suspended by slips set in the table bushing.

Began at Spindletop

In the 1800's various primitive type rotary machines were used to drill both water and oil wells. Date of birth of the modern rotary table, however, is generally taken as 1901 at Spindletop, Texas. Although the rotary table has been modified and improved since its conception, it is still essentially the same piece of machinery. As in early models, the modern rotary table consists of a ring gear which carries a bushing to drive the drill pipe and a pinion to drive the ring gear. (Fig. 1).

The present day ring gear is spiral beveled, as compared to the earlier straight bevel gear. The over-lapping action of the teeth tends to eliminate shock and provides a smoother running machine. The gear is machined from alloy steel and the teeth cut before heat treating. The teeth are then flame-hardened to provide maximum wear resistance.

The gear table is an alloy steel casting on which the ring gear and upper race of the main bearing are shrunk. The table skirt is provided with studs, which secure a ring to lock positively the hold-down thrust bearing. In addition to carrying up thrust, the hold-down bearing, together with the main bearing, provides accurate table alignment.

Driving Square

The master building is a split steel casting with API standard driving square for the kelly bushing and slip seat. Recesses are provided in the bushing for a lifting hook to facilitate handling on the rig floor. The bushing is seated in the table casting. As may be noted in Fig. 2, early tables had, in place of the square for the kelly bushing, a grip ring attached to the turntable. The rollers clamped directly on the drill pipe. This drive often resulted in crushed drill pipe.

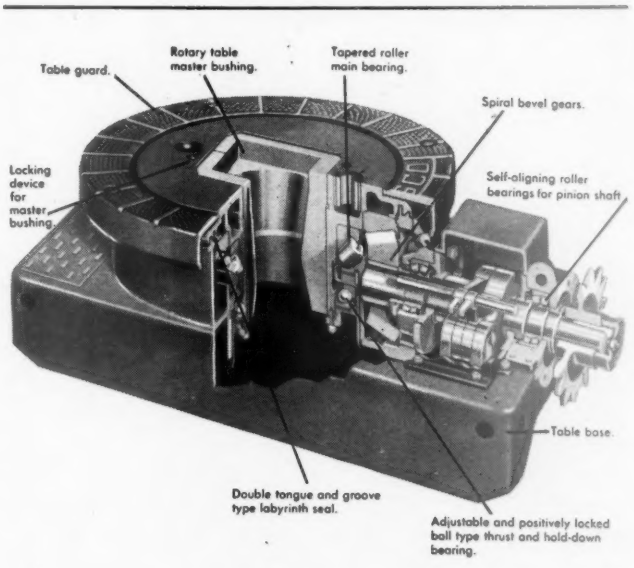


Table guard.
Rotary table master bushing.
Tapered roller main bearing.
Spiral bevel gears.
Locking device for master bushing.
Self-aligning roller bearings for pinion shaft
Table base.
Double tongue and groove type labyrinth seal.
Adjustable and positively locked ball type thrust and hold-down bearing.

FIG. 1. Cutaway view of modern rotary table, showing various parts of modern unit.

A natural modification was the introduction of a heavier-than-drill pipe grief stem to ride in the grip ring. The familiar kelly soon followed. Much later a table ring guard, with a non-skid thread on its upper surface, was introduced to provide greater safety for the men working around the rotary. It also provided a convenient place to set the slips when "tripping."

The pinion shaft assembly consists of an alloy steel shaft

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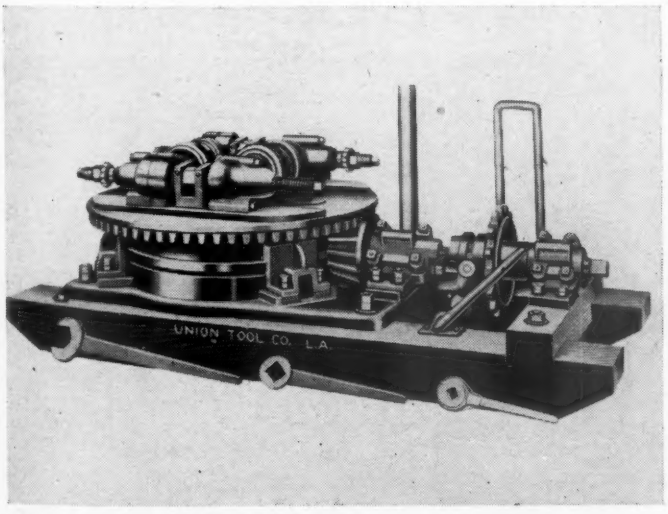

FIG. 2. Early model rotary table had a grip ring attached to turntable.

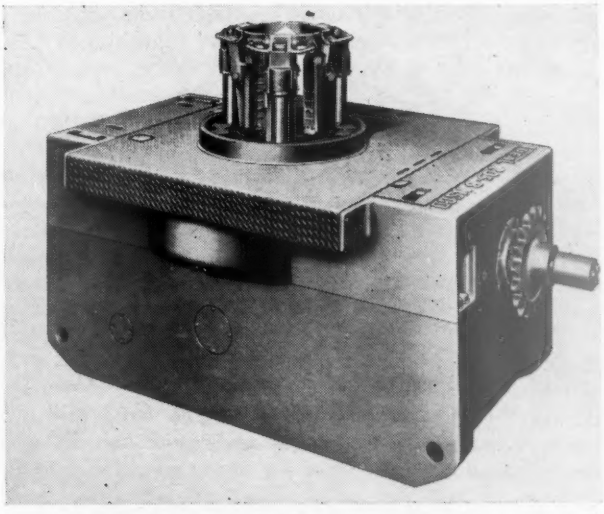

FIG. 3. In modern rotary tables power slips may be an integral part.

Simplicity and Compactness

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Ideal for Medium and Low Pressure Wells

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- Uniform slip support by unitized design.
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with the pinion gear shrunk on it. The shaft is supported by two roller bearings mounted near the respective ends. Shaft lock collars are mounted on the shaft between the bearings. Two pawls actuated manually by handles mounted on the outside of the table engage the lock collar and may be used to lock the table against rotation in either direction.

The assembly is factory aligned, or equipped with self-aligning bearings, so as not to require adjustment of the contact with the main gear in the field. As in the case of the main gear the teeth of the pinion gear are hardened to resist wear.

Lubrication

The majority of the moving parts in the rotary table are flood lubricated, the remainder lubricated through conveniently located alemite grease fittings. The main base acts as a sump which holds the oil in which the ring gear and main bearing run. Although the pinion is flood lubricated, it is not always lubricated from the same sump as the ring gear. Some manufacturers provide a separate reservoir to carry the lubricating oil for the pinion gear and inner pinion bearing. The outer pinion bearing and hold-down bearing are usually, but not always, grease lubricated. The particular advantage in a machine completely flood lubricated is that "greasing up" every tour can be eliminated. Lubrication oil need be added to the rotary table only at infrequent intervals.

The main base, in addition to serving as an oil sump, provides support for the table casting, through the main bearing, and for the pinion shaft assembly. It is frequently an alloy steel casting, but may be made from preformed steel plate and welded. The top of the base is provided with a non-skid surface. A tongue and groove labyrinth seal between the table and the base make the lubrication system slush proof.

Size

The size of the rotary table is taken from the diameter of the opening in the table through which the bit passes. From the beginning there has been a tendency to increase the size of the table. The practical limit is governed by both the ability of the moving parts to withstand the increased loads imposed upon them by virtue of their larger size, and the logical upper limit of hole diameter. The largest tables today have an opening of 27½ in. The 20½-in. table, however, suffices for most drilling purposes. The particular advantage in avoiding oversized tables is that smaller tables will permit greater drilling speeds and loading. With new drilling techniques, rotary speeds greater than 300 RPM are sometimes necessary.

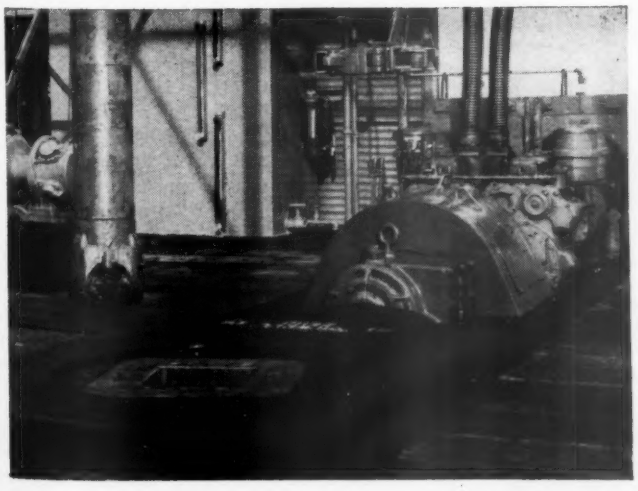


FIG. 4. Separate engines are sometimes used to drive rotary table.

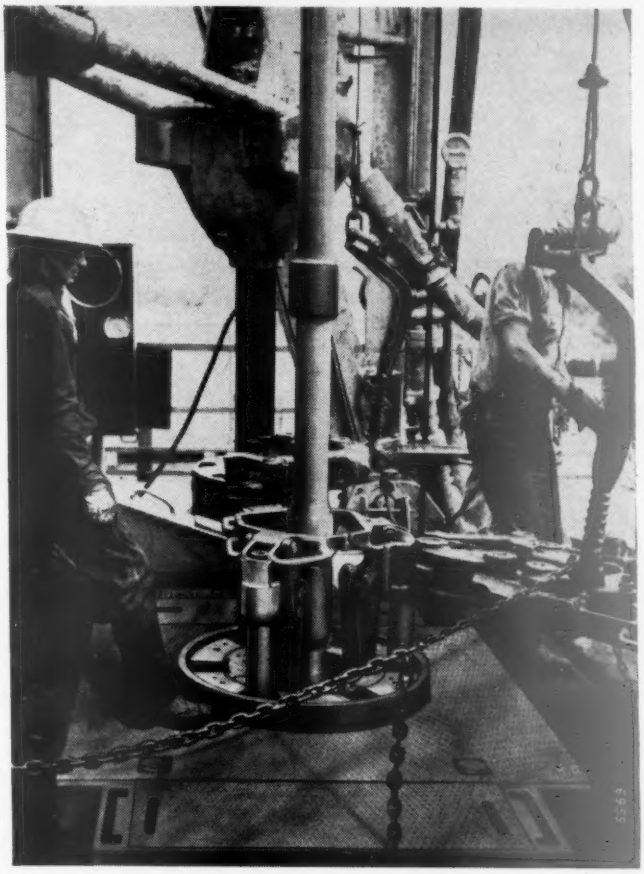


FIG. 5. Field view of multimatic rotary.

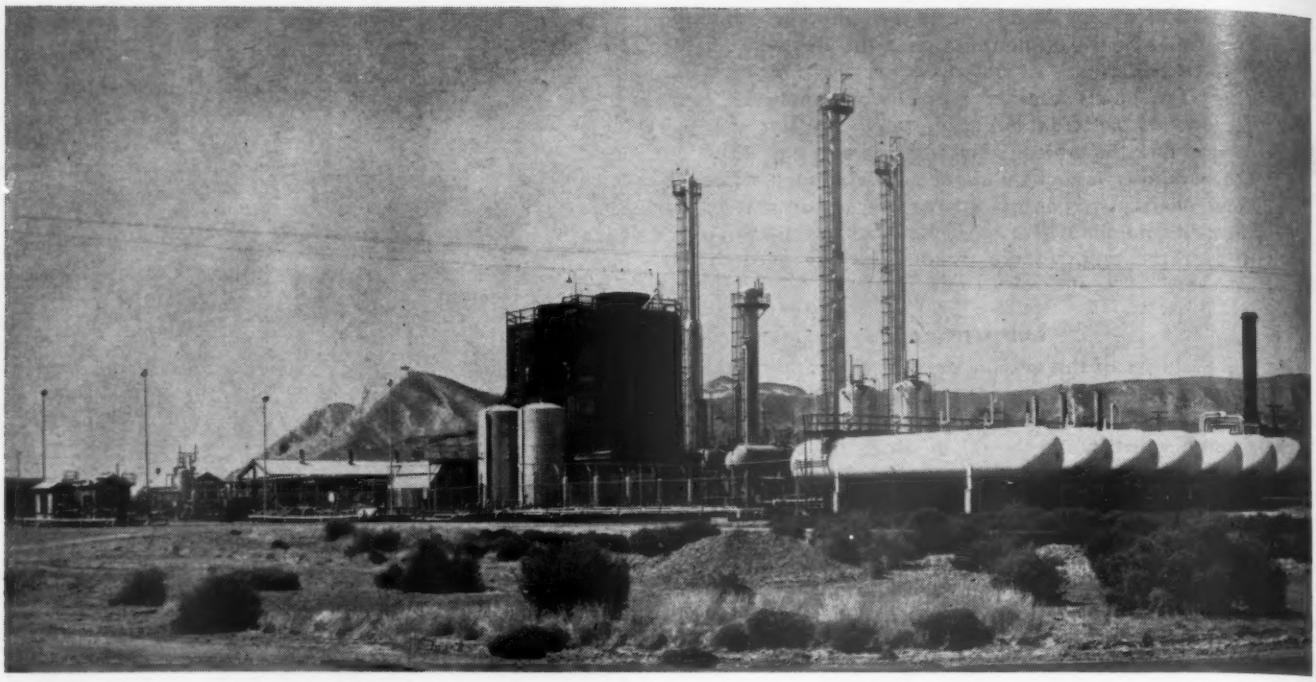
Power

Most rotaries take their power through the draw works, by means of chains and sprockets, from the primary engines. This results in an obstruction, in the form of a chain and guard, extending half way across the derrick floor. In recent years, with the trend toward deeper drilling, there has been a move toward using a separate engine to drive the rotary table. (Fig. 4). The principal advantage of the auxiliary power is that, with the proper layout, it may be used in an emergency in place of the primary power plant. The elimination of the obstruction caused by the chain drive reaching from the draw works to the rotary table is also a great convenience.

Power Slips

One of the most significant advances in rotary table design in recent years has been the inclusion of power slips as an integral part of the table. (Figs. 3 and 5). The disadvantage of the overhang associated with power slips that are mounted externally on the table is thus eliminated. The slips are actuated by air pressure, controlled through a pedal at the driller's position. Through the use of slip bowls the conventional master bushing is no longer required. Separate bowls are used for drill pipe and casing, except for casing 5½ OD or smaller which can be run through the drill pipe slip bowl. When necessary changeover from drill pipe slips to casing slips can be effected in only a matter or minutes.

The kelly is driven directly from the table. This arrangement avoids the trouble that is sometimes experienced by the drilling crew in getting the kelly bushing to slip into place. The operating levers for the pinion shaft lock assembly are situated on top of the pinion shaft housing, as contrasted with the usual side location. This arrangement permits the table to be mounted flush with the derrick floor if desired.



Richfield Oil Corporation's Russell Ranch field gas processing and pressure maintenance plant 100 air miles northwest of Los Angeles.

RUSSELL RANCH FIELD

New Reserves Through Unit Operation

W. S. PAYNE, JR.

THE week of June 13, 1948 marked another milestone in oil prospecting history of California. During that week two wells, located more than two miles apart, were completed and thereby opened up the Cuyama Valley as a new and significant oil producing province.

The Russell Ranch field was named after the ranch upon which it was discovered while the Dibblee producing zone was given the name of the Richfield geologist whose surface mapping of the area had greatly contributed to the discovery. The field has since proven to be a major one, having produced more than 28,000,000 bbl of oil as of this date.

Less than a year following discovery, an engineering committee had been formed by direction of the interest owners and a unit plan of operation became effective in September of 1950. Pressure maintenance operations by gas injection were, by agreement, commenced prior to unitization and are still continuing. During the past year, a pilot water flood has been successfully operated and a full scale water injection program is being inaugurated.

It has been estimated that the unit operation utilizing gas injection alone would add more than 13,000,000 bbl of producible oil reserves. The combination of water injection and gas injection during the primary producing phase of the field is expected to increase the ultimate recovery by more than 50,000,000 bbl.

Thus Richfield Oil Corporation and the Hancock Oil Company have joined together with 9 other non-operating working interest owners and more than 120 royalty interest owners in effecting a unit operation and are thereby very substantially increasing the economic oil reserves of the field.

The Author

W. S. Payne, Jr., is chief production engineer for Richfield Oil Corporation.

A graduate of the University of Southern California with a BS in petroleum engineering, Payne joined Richfield in 1940 in the research department. From 1946 to 1949 he worked in the San Joaquin Valley district for Richfield as a development engineer and was engineer in charge of the Cuyama Valley at the time of the Russell Ranch field discovery. Payne was transferred to the Los Angeles office in 1949 to represent Richfield in the engineering negotiations for the Russell Ranch unit. He was formerly chief evaluation engineer prior to being named to his present position.

EXCLUSIVE

Geology

The Russell Ranch field lies in the western part of the Cuyama Valley a few miles south of the well-known San Andreas Fault and approximately 100 air miles northwest of Los Angeles. The Valley is about 50 miles in length and as much as 15 miles in width at the widest point. The basin itself is essentially a graben with the San Rafael uplift to the south and the Caliente uplift to the north.

The structure is primarily monoclinal with structural closure against a large, lateral fault. This fault has been

XUM

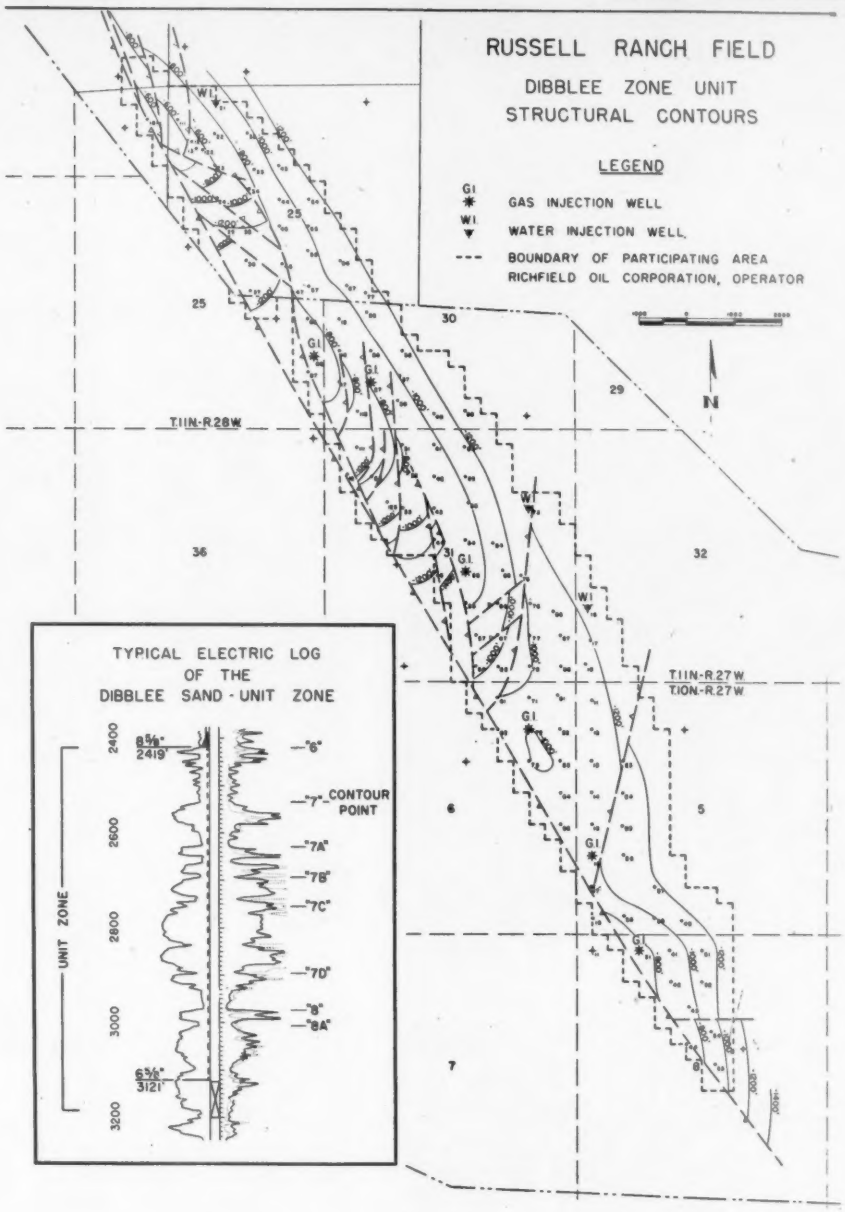
named the Russell Fault and has an apparent vertical displacement of approximately 1500 ft. The equally large, relative recent White Rock thrust fault has caused all but the southerly portion of the field to be overlain by Miocene shales. These same formations form the Caliente mountains to the north.

Up-structure wells penetrating this fault have shown apparent stratigraphic displacements upward to 2000 ft. Down-dip wells indicate that the thrust fault is rapidly becoming a bedding-plane slip with apparent displacements approaching zero. It is significant that while the fault outcrops in the Caliente mountains and is readily mappable, it has no apparent effect upon the accumulation of oil in the field. Considerable cross faulting intersects the producing zone and has complicated the structure by warping the beds and creating an anticlinal appearance.

The section differs markedly in individual wells because of repetitions and omissions due to penetration of the White Rock and Russell faults. In general, however, the sequence consists of approximately 800 ft of Pleistocene conglomerate, Pliocene sands and gravel of 500 to 1000 ft in thickness, upper Miocene sands from 300 to 2000 ft, middle-lower Miocene shale to 1300 ft and the Dibblee producing horizon of lower Miocene age with thicknesses up to 650 ft. The pool is about 4¾ miles long and ½ mile in width.

The producing sand is a medium to coarse, unconsolidated sand interbedded by a number of impermeable blanket shale members. The upper 200 ft of the producing interval has a maximum of 100 ft of net oil sand having an average permeability of approximately 150 millidarcies. The next 450 ft or Main sand interval has up to 285 ft of net oil sand with an average permeability of 400 millidarcies. Porosity in general averages about 25 per cent.

The water table on the flank of the structure occurs at 1310 ft subsea at the south end of the field and has a slight upward tilt in going to the north. Demonstrated closure amounts to 1285 ft.



Development

Prior to the week of June 13, 1948, less than 12 very shallow test wells had been drilled in the entire Valley. All of these wells for one reason or another were abandoned before reaching conclusive depths. On June 13, 1948, the Russell Ranch discovery well, Russell No. 28-5, located in the extreme southerly end of the field was completed from a total depth of 3360 ft. The initial production was 508 bbl per day of 38.3 deg oil through a 48/64-in. choke with 160,000 cu ft of gas. Five days later on June 18th, the Richfield's Anderson-Colgrove No. 37-30 well was completed at a total depth of 3022 ft for an initial production of 4000 bbl per day of 32.8 deg oil. This proved to be a significant extension of the field even though at the time it was believed by some to be a separate pool.

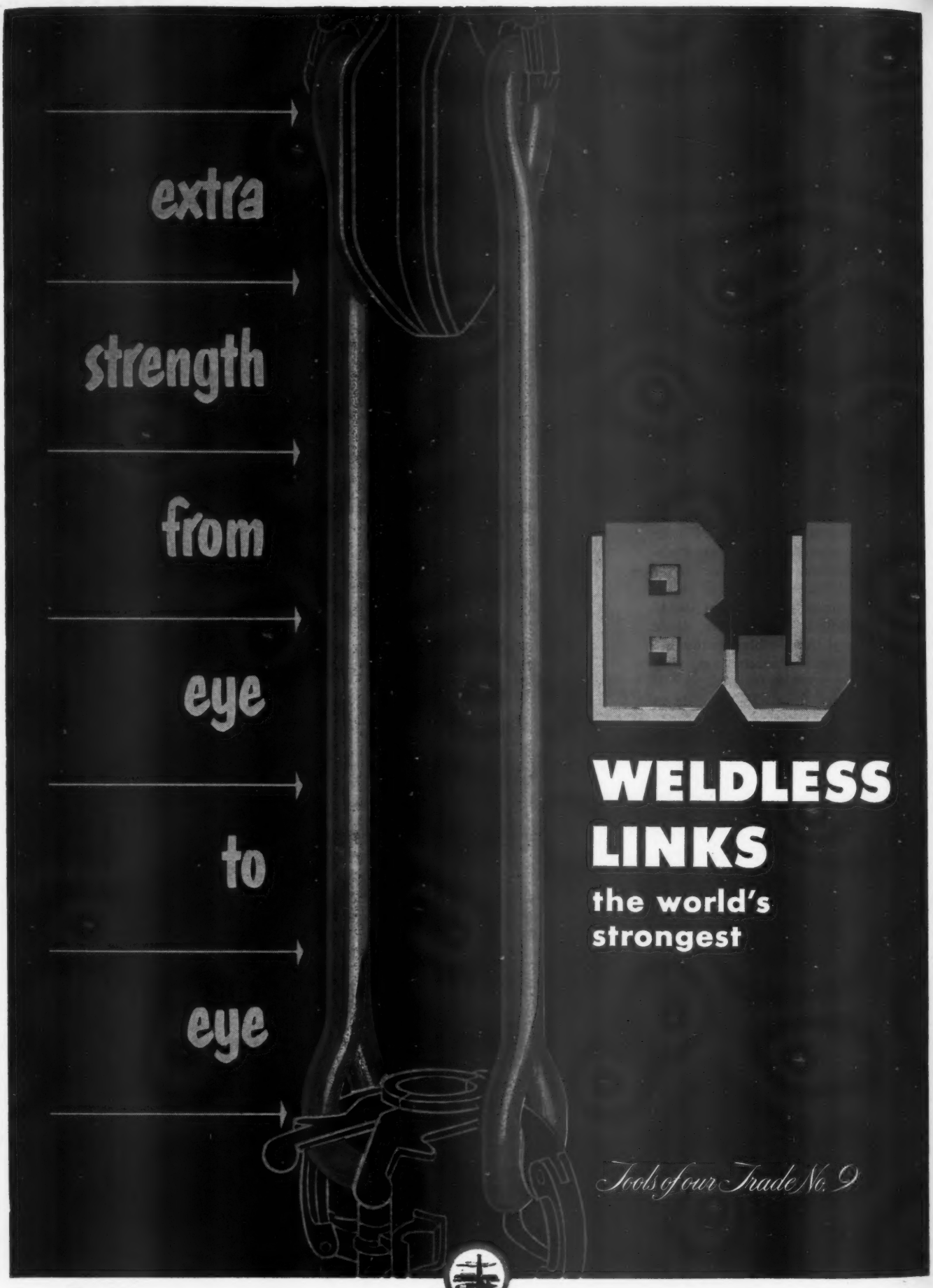
Following completion of these 2 wells, a vigorous development program was commenced. Portable rotary drilling equipment was used and as many as 12 strings of tools were operating at once. A total of nearly 90 wells were completed in the following year and by January of 1950 the field was essentially drilled up by a total of 101 producing wells, all drilled on a regular 10-acre spacing. The productive limits of the field were well established by more than 10 dry holes.

Concurrent with the completion of the development program, the peak production rate from the pool of nearly 19,000 bbl per day was reached.

The benefits of operating the field with pressure maintenance by gas injection soon became apparent and in the interest of gas conservation, it was decided to commence gas injection as soon as possible. While design work was being undertaken for a gas processing plant, four 300-hp compressors were installed and went into operation in January of 1949.

The wet gas from the field which amounted to 4,000,000 ft a day was compressed, and after recovering the condensate, was injected into Well No. 31-8, located in the south end of the field just one location away from the discovery well. In October of 1949, the processing plant was completed and placed in operation along with four additional 660 hp compressors. Since that time, a fifth 660 hp compressor has been added.

The plant is of the conventional ab-



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sorption type employing rich oil de-ethanization and produces de-propanized natural gasoline and propane. Glycol-amine treating facilities are used for dehydration and hydrogen sulphide removal.

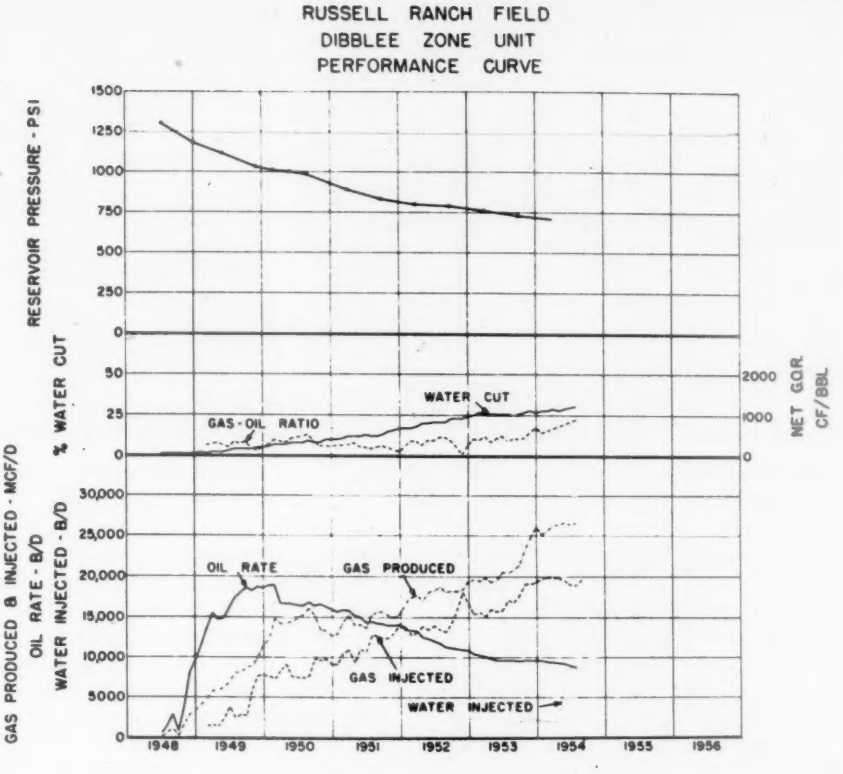
Inasmuch as the new field was located some 30 miles from the nearest producing area in the San Joaquin Valley and discovery was at a time of severe shortage of steel line pipe, it was necessary for initial shipment of oil, to lay a 6-in., light weight pipe line, of the type used by our Army in France. By April, 1949 this temporary line had been replaced by a permanent 8⅝-in. line having a potential capacity of 35,000 bbl per day. It wasn't until October of 1950 that a gas transmission line was completed to serve as a sales line for any gas that might be produced in the Valley in excess of injection requirements.

The wells, completed at an average depth of 3500 ft, were drilled in approximately 20 days at a cost of $60,000. Approximately 18 bits per hole were used. The casing program consisted of cementing 12¾-in. casing at 200 ft, 8⅝-in. casing cemented at the top of the producing interval and completed by hanging a conventionally slotted 6⅝-in. liner.

Liner perforations were for the most part 100 mesh undercut slots, 2½ in. in length on 6-in. centers. The flow string was 2½-in. set on a packer at or near the top of the liner with tubing tail extending to bottom. Prior to setting the packer, the drilling fluid was replaced with oil and most of the wells were thereby circulated on production or brought on with a few runs of the swab.

Inasmuch as the potential advantages of bringing this pool under unit operation were recognized very early in the development program, more than 14,000 ft of cores were taken in the producing interval during the development period. Of these cores, more than 2000 representative samples were taken and analyzed for permeability, porosity, and saturation characteristics. One well was completely cored in oil base mud in order to obtain interstitial water data.

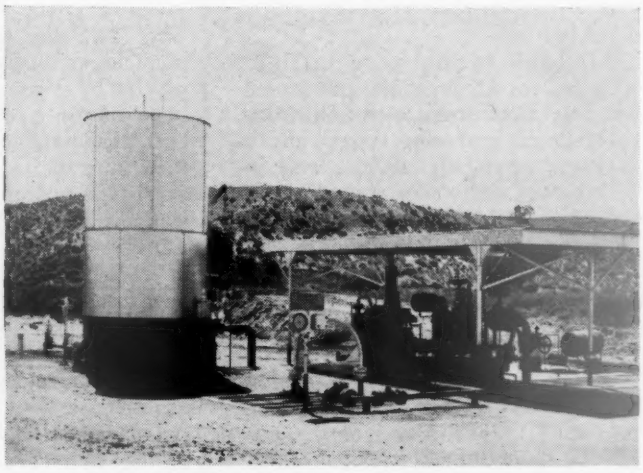
Oil and gas samples were taken early in the life of the pool for pressure-volume-temperature and viscosity studies. Subsurface pressure data and productivity index measurements have been made at regular six-month intervals commencing with discovery. This wealth of data aided the engineers greatly in arriving at a sound and equitable determination of equities for unitization.



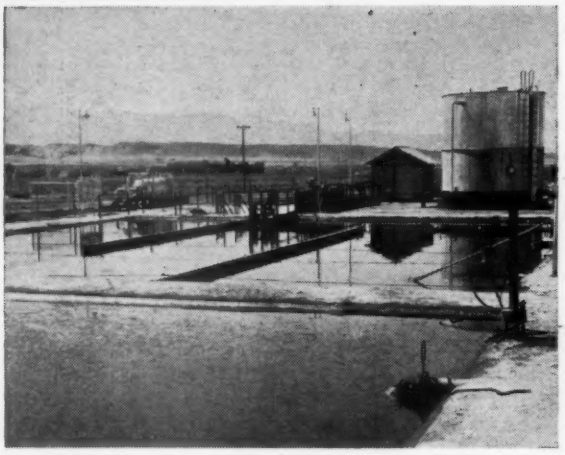
Unitization

Inasmuch as less than a week after discovery the size of the Russell Ranch field was demonstrated to be at least 2¼ miles in length and with a net pay zone of nearly 300 ft, the advisability of producing under some type of pressure maintenance program was clearly indicated. The complexity of ownership, together with the geologic conditions as they were known, made a unit operation imperative if pressure maintenance was to be pursued. It was decided to commence with a gas injection program at a local structural high in the south end of the field controlled by a single operator, while negotiations were being carried on for unitization. By direction of the operators and roy-

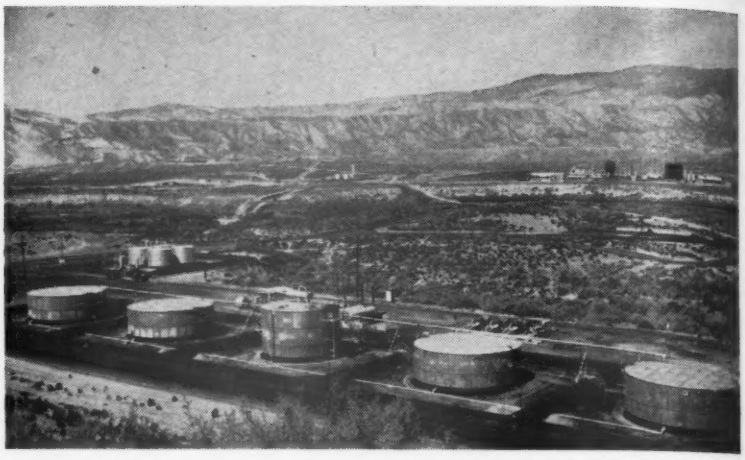
Gas injection well, left, is equipped with three-interval controlled injection. Water injection well, right, operates with two-interval controlled injection.



Russell Ranch field waste water treating plant, left, has a 20,000 barrel per day capacity; right, the central dehydration plant battery.



Wash water treating plant has a 20,000 bbl per day capacity.



Central dehydration plant is equipped with 5000-bbl wash tank and four 5000-bbl stock tanks.

alty owners, an engineering committee was formed in April of 1949 to determine the participating equities in the proposed unit. Their work was completed and a unit operation became effective on September 1, 1950. Participation was based on weighted acre-feet of net oil sand underlying the individual leases.

Because of lower permeability and productivity characteristics of sands in the upper 200 ft of the Dibblee zone, those acre-feet were discounted by a factor of .5. The balance of the zone had a weighting factor of unity. While Richfield Oil Corporation and the Hancock Oil Company were the only operators in the pool, 9 non-operating working interest owners and more than 120 royalty interest owners were involved in the negotiations, all of whom consented to and are parties to the unit agreement. Richfield, having the largest interest, was named as the operator.

Production Facilities

Virtually all of the unit producing wells which now total 112, were completed as flowing wells, producing oil averaging 35 deg API gravity with a solution gas-oil-ratio of about 350 cu ft per barrel.

All tank farms were initially equipped for 15 psi initial gas separation only. Concurrent with unitization, a 130-lb gas gathering system and 2-stage gas separation facilities were installed along with vapor recovery facilities and a central dehydration plant. The individual tank farms continued in operation for gas separation and individual well testing.

All oil and any water production from these tank farms is shipped to the central dehydration plant for cleaning. Oil shipments from the unit are made from stock tanks in that plant.

Now, more than 6 years after discovery, approximately half the wells are still flowing with surface pressures up to 850 psi. Those wells incapable of flowing are produced by conventional rod-operated pumps. All pumping wells are treated chemically for hydrogen embrittlement-type corrosion.

About a year following discovery, some water commenced to be produced from the unit zone. Currently water production amounts to nearly 3500 bbl per day. Inasmuch as the Cuyama Valley is an agricultural area, pollution of the surface ground water had to be avoided. Disposal of the saline waste water was first carried on through evaporation sumps located some 300 ft above the field in the Caliente Mountains to the north. These sumps proved inadequate and thereafter two previously abandoned exploratory holes in the same vicinity were re-entered and completed for subsurface disposal. These wells had penetrated a thick salt water sand which by surface mapping and subsurface information appeared to be an adequate salt water reservoir. These wells proved to be a good, temporary solution to the disposal problem.

The need for going to subsurface disposal made it necessary to treat the disposal water so as to eliminate any plugging effect in the disposal wells. This gave rise to the water treating plant in which field water is rendered oil free by skimming in large concrete-lined sumps, treated for scale prevention, bacteria, corrosion control, and then filtered through diatomaceous earth-type pressure filters. The treated water is then shipped to the injection wells at about 300 lb pressure by means of centrifugal pumps. Treating costs have been quite low and no difficulty has been experienced in rendering the water stable. As a result, no loss of injectivity in injection wells has been experienced.

Located at each of the 3 water injection wells and operated by automatic controls is a high pressure injection pump. This pump takes suction from a 250 bbl, 2-ring tank which in turn receives stable water from the treating plant. The water level in this tank is controlled automatically. Controlled injection rates in the 2 segregated intervals is accomplished by means of surface beans.

Gas Injection

The gas injection program utilizes six injection wells located for the most part on structural highs in the various fault blocks. Inasmuch as no initial gas cap existed in the field, it was therefore a case of the injection wells supplementing the secondary gas caps that were beginning to form.

Initially, gas was injected into the full section of Dibblee zone through 2½-in. tubing set on a packer and landed at or near the bottom of the pay interval. Some bypassing of gas was experienced and temperature survey data indicated that in some cases gas was preferentially entering only ceratin portions of the producing interval. To remedy this, cement scabs were placed across certain impermeable barriers within the producing interval and by means of bottom hole packers run on multiple strings of tubing, injection is being carried on at controlled rates in as many as three intervals within a single well bore.

Gas injection rates in the various wells have been as high as 5,000,000 cu ft per day per well with injection pressures ranging from 1200 to 1800 psi. As of this date, nearly 25 billion cubic feet of gas has been injected at rates up to 20,000,000 ft per day. This amounts to 72 per cent of the total gas produced since discovery and gives a net produced gas-oil ratio of 338 cu ft per bbl which is approximately equivalent to the initial solution gas-oil ratio of Dibblee zone oil. Some plugging of the injection wells has been experienced but treatment with 400-500 gal of hydrochloric acid has successfully restored well injectivity.

It was originally thought that no

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additional makeup gas could be utilized even if and when it might become available. Therefore, the pressure maintenance would be essentially one of retarding pressure decline rather than full pressure maintenance. This has proven to be the case. Gas injection has prevented increase of oil viscosity and aided in locating effective fault barriers.

It was further recognized early in the life of the field, that the shape of the pool (nearly 10 times as long as it is wide) would limit the economic life of a pressure maintenance program by gas injection. It was estimated at that time that this life would amount to approximately 4 years. With this in mind, the feasibility of ultimately converting transitionally to pressure maintenance by peripheral water injection was explored.

In this connection laboratory and engineering studies were made to determine the susceptibility of the pool to increase recovery by water injection. Likewise, regional investigations were conducted to establish a suitable source of makeup water.

Water Injection

In September of 1953, a pilot water injection operation was commenced in a fault block at the extreme north end of the field. The location for the pilot operation was chosen where one injection well and three producing wells were believed to be reasonably isolated through faulting. The results have been very encouraging. Nearly 50,000 bbl of oil have been produced as of this date in excess of the estimated amount of oil that these wells would have produced without water injection. Injection in this pilot well is being carried on at controlled rates in 2 segregated intervals.

Well No. 73-31, a previously abandoned flank well outside the productive limits and in the central portion of the field, was redrilled and completed as an injection well in May, 1954. Water in the amount of 7500 bbl per day is being injected into this well in 2 segregated intervals at controlled rates and at pressures up to 450 psi. As of this writing, Well No. 16-32 is being recompleted as a third water injection well.

Nearly 10,000 bbl per day of waste water from the field which heretofore had been disposed of through subsurface injection is now being returned to the unit zone.

Some of the wells which previously were used for subsurface waste water disposal will be produced as sources of makeup water. An additional water source well will be drilled in the near future to an upper salt water sand and be completed with a producing interval of 1000 to 2500 ft drilled depth. It has been estimated that 175,000,000 bbl of makeup water will ultimately be required.

Production History

The Dibblee Zone Unit had an original reservoir pressure of 1300 lb at a subsea depth of 1070 ft. This pressure, prior to commencement of gas injection, was declining at the rate of 1 lb per 25,000 bbl of oil produced. Since, the commencement of gas injection and unitization recovery efficiency has been more than doubled. Gas-oil ratio performance has not been as satisfactory as might be desired, however recovery efficiency has been very good. It is predicted that the gas injection phase of the unit operation would produce 13,000,000 bbl of oil that would not have been recovered otherwise. This is in very good agreement with estimates that were made at the time the unit was formed 4 years ago.

The oil rate, under voluntary curtailment as is practiced in California, has been declined in an effort to obtain ultimately the economic maximum recovery of oil. Gas plant capacity for processing and injection has been reached and very recently small quantities of gas have been produced and sold in lieu of injection.

The pilot water injection program now commencing its second year of operation, is producing oil at more than twice the rate that these wells would have been producing at this time. Recovery efficiency by that means appears very favorable. Laboratory data indicates a possible water flood recovery of nearly 65 per cent of the original tank oil in place.

Water injection wells have demonstrated injection capacities up to 10,000 bbl per day thereby making it economically feasible to maintain pressure through peripheral water drive.

It is felt that for maximum sweeping efficiency, injection operations must recognize the Dibblee zone to be

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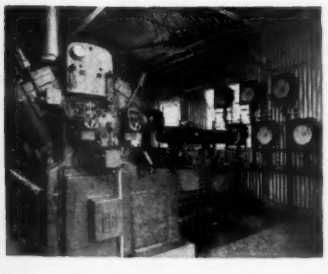

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several sand members separated by relatively continuous impermeable members, and to the degree economically possible, injection should be carried on by segregating and controlling injection rates in these individual strata. A technique is being developed in which it is hoped that four or five more individual strata can be supplied with water at controlled rates through a single well bore. If such techniques prove successful, it is believed that sweeping efficiency will be significantly improved.

Conclusions

After four years of unit operation, the Russell Ranch Dibblee Zone Unit is demonstrating the desirability of a unit operation. Pressure maintenance operations by gas injection have been successfully carried on with significant benefits. At the same time, the mobility of the yet to be recovered reservoir oil has been preserved for recovery by water injection. This operation promises to produce even greater rewards.

Several new production techniques aimed at getting more oil out of the ground have been developed and other new ones are in the process of development.

The results have been the development of new oil reserves by virtue of operating the field as a pool with the aid of artificial stimulation in the form of gas and water energy.

Acknowledgments

Consent for publication of this article was given by the operating committee of the Dibblee Zone Unit. Acknowledgment is made for the assistance given by the staffs of the exploitation and the exploration departments of the Richfield Oil Corporation.

* * *

Carter Honored

Recognition for outstanding achievement in the field of highway safety was given the Carter Oil Company when the Merit Award of the National Safe Drivers Association was presented to Thomas Brownfield, vice president of the company, by Robert B. Sprinkel, NSDA president.

President Sprinkel reported that Carter workers in the past year have driven 14,500,000 miles with an accident rate 4 times lower than the national average.

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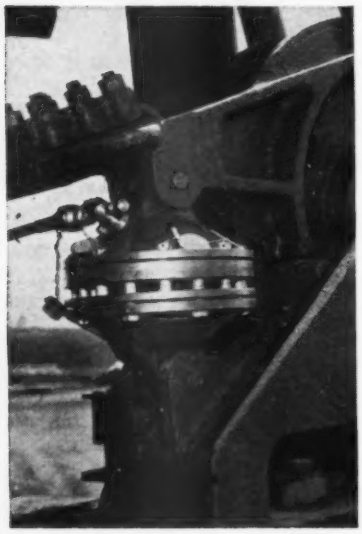

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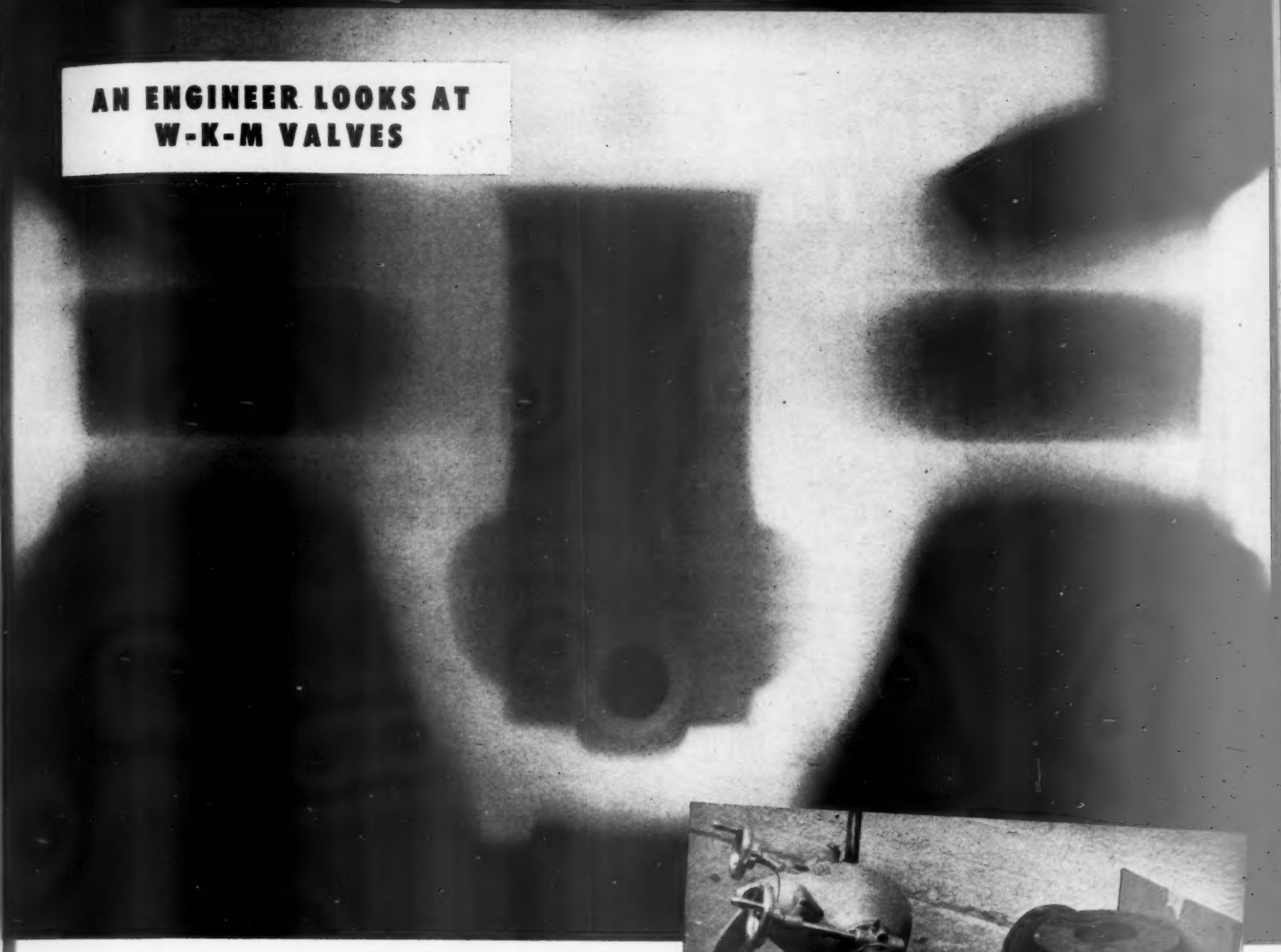

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Bottom: The gamma ray "camera" contains 5000 millicuries of Cobalt 60, capable of penetrating 6" steel in 3.5 hours.

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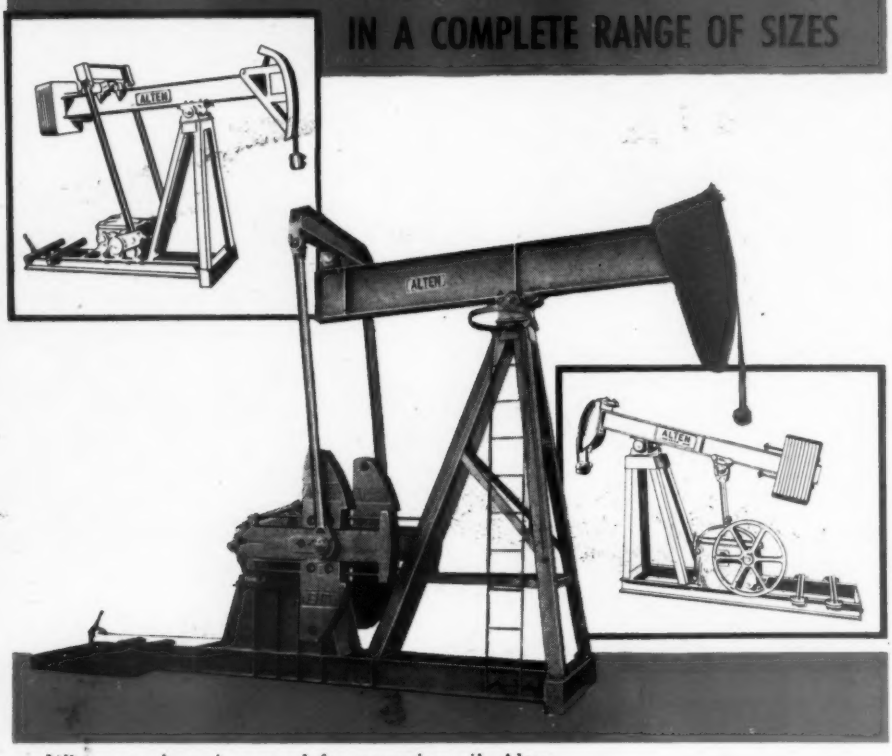

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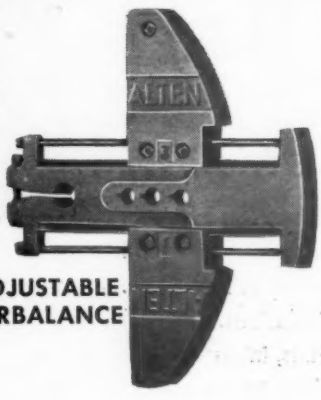

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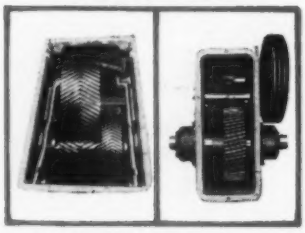

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Manassa Mauler or BJ Representative?

A recent issue of Guayaquil, Ecuador's daily newspaper, "El Universo," carried the following interesting item (freely translated):

"The Sports Department of El Universo last night was excited over the expected arrival of the ex-world's champion boxer, Jack Dempsey, who was to have passed through on his way from Buenos Aires to his native country, having been invited to Argentina by President Peron. Dempsey's 'fight of the century' with Louis Angel Firpo, the 'Wild Bull of the Pampas,' gained world-wide attention.

"We found ourselves confronted in the hall of the Hotel Metropolitano by a gentleman 6 feet tall and 96 kilos in weight, resembling the ex "Manassa Mauler" as much as one drop of water resembles another. But the passing years and change of profession have have made Jack, the former "Terror of the Ring," an affable gentleman, very cultural, who did not protest when an impertinent photographer snapped his picture without permission.

"But he turned out to be not the ex-monarch of the heavyweight division, however strong the resemblance. His business card read: 'Jack S. Smith, Foreign Representative, Byron Jackson Co., Los Angeles, California.'

"Officially, then, we have not had Jack Dempsey, but it would be difficult to find anyone who resembled him more; and for our part, and that of all those who had the pleasure of talking with him, the greatest boxer of all time was in Guayaquil last night."

Reported Jack Smith, who makes frequent trips through South America in his oil tool sales capacity: "While I knew we had a popular line of oil tools, I frankly was surprised to find such a crowd of people waiting to shake my hand. Then, when I discovered that a mistake in identity was the cause for the excitement, I had considerable difficulty persuading everyone that 'Jack Smith' was not an alias assumed by Señor Dempsey. Luckily I was able to fight my way out with words."

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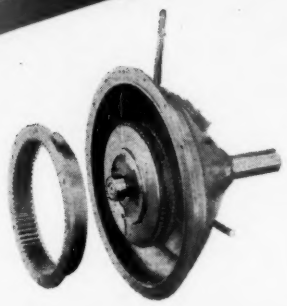
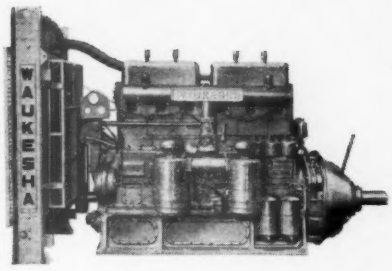
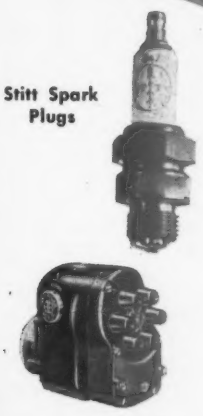


Twin Disc Clutches & Hydraulic Units

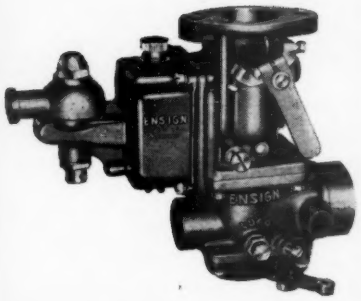


Waukesha Engines and Parts



Stitt Spark Plugs

Bosch Magnetos



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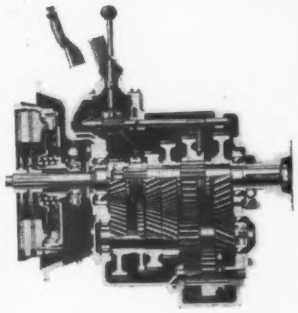
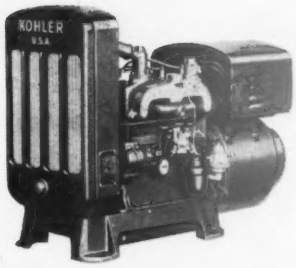
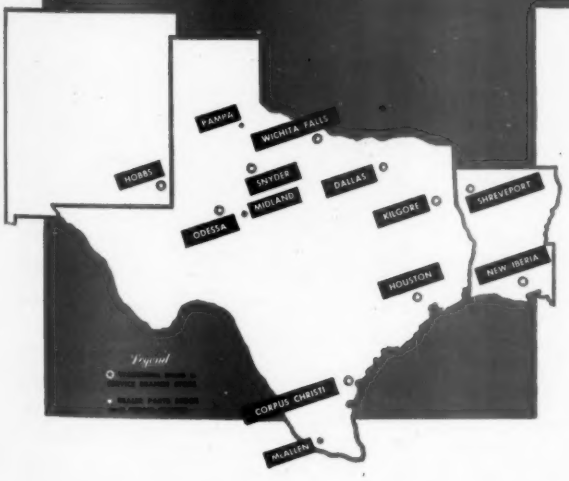


Spicer Transmissions and Parts



Kohler Electric Plants and Air Cooled Engines



When your Waukesha Engines or Kohler Electric Plants and air cooled engines need professional attention, you are assured of quick, efficient repair service from Waukesha Sales and Service, Inc. Our 11 modern branches, located strategically throughout Texas, Louisiana and New Mexico, stock a full line of nationally known parts and maintain experienced, factory-trained mechanics who know how to keep your down-time at a minimum. Furthermore, this dependable service is at your call twenty-four hours a day to help you when you need it most.

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A "plastic pipe liner" carries 300 ft of plastic pipe, in 30 ft joints, to point where it will be used on a pipe line to carry salt water from a group of oil wells to a salt water disposal well. The 2-in pipe is made of plastic and weighs a total of 75 lb for the 300 ft.

Salt-Water Disposal Problems Solved by . . .

PLASTIC PIPE LINE

A 12-mile plastic pipe line, one of the longest continuous plastic pipe lines in the United States, was recently installed at a speed of almost a mile a day near Heidelberg, Mississippi, to carry unwanted salt water from 25 oil wells to a central disposal plant.

The pipe line solved a common problem of 14 independent oil operators in Heidelberg. They decided to get rid of salt water from their wells by pumping it back into a deep disposal well.

The pipe used is tough corrosion-resistant blend of plastic and rubber produced by the Naugatuck Chemical division of United States Rubber Company, extruded into 30-ft lengths, 2 to 6-in. in diameter.

Plastic was used because it was inexpensive and could be installed fast. It is flexible enough that straight trenches with flat bottoms were not needed.

The East Heidelberg Salt Water Disposal Company was formed to build and operate the line to carry salt water from the separate wells to a disposal well. The line, as laid out, is more than 90 per cent down hill, and has pumps at only two points.

Behind the ditcher, a three-man pipe-laying crew performed the actual construction, using a pick-up truck with improvised side racks to carry 30-ft joints of 2-inch pipe.

Two of the crew did the "stringing" along the ditch, shouldering 10 sections of the pipe weighing a total of 75 lb at one time. The third man, working alongside the ditch, made joints by solvent welding.

The pipe has a built-in fitting on one end. Using a paint brush, the man making joints smeared cement on the inside of the fitting and the plain end of another section. The plain end was then forced into the fitting. In a minute the joint was made. When several hundred feet of pipe had been joined, the other two men in the crew lowered it into the ditch.

Two men did the "stringing"; a third made joints by solvent welding.

The pipe was then snaked into long, smooth curves to take care of any contraction or expansion caused by temperature changes.

When connections from wells were tied-in, pipe was cut with a hack saw and a fitting cemented in place. ★ ★ ★

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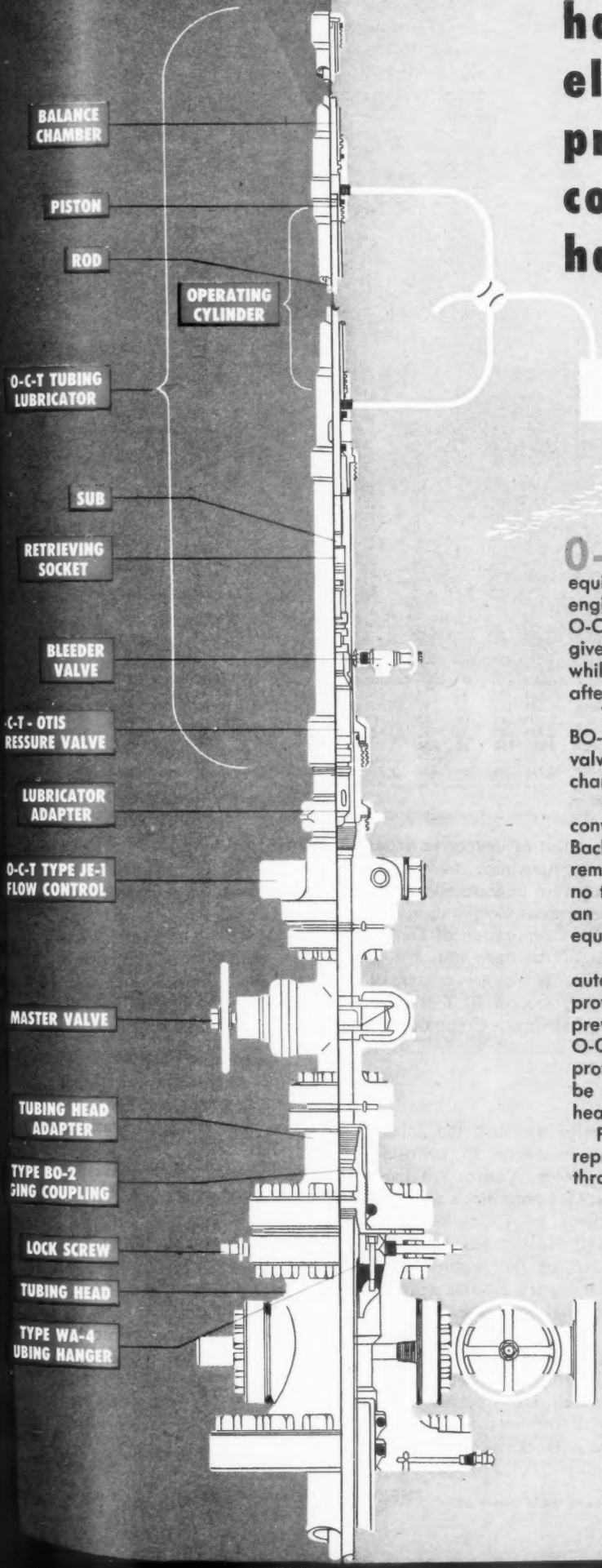
How O·C·T-OTIS have combined to eliminate high pressure well completion hazards



O-C-T, the leader in high pressure oil field equipment, and Otis have combined their engineering skills to design and manufacture the O-C-T - Otis Back Pressure Valve. This valve gives you complete protection against blowouts while blowout preventers are being removed after tubing has been landed.

The O-C-T - Otis Back Pressure Valve and the BO-2 coupling are also adapted to run and set the valve into the coupling under pressure when changing a Christmas tree master valve.

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EXPLORATION ACTIVITIES

TEXAS

★ Cities Service's Texas TXL "O" No. 1 well in Ector County, flowed at the rate of 1288 bbl of oil daily on a 3.5-hr drillstem test. The Ector County well is 1 mile south of the North Goldsmith field, opened earlier this year. On drillstem test of the Ector County well between 8295 and 8360 ft, opposite the Fusselman limestone, gas was clocked at the surface in 5 minutes, oil in 20 minutes. After cleaning to the pits, the well flowed 161 bbl of 39.8 gravity oil in 3 hours. Flow was through one-in. top and bottom chokes and the gas-oil ratio was 1250-1. Surface pressure was 175 lb, initial flowing pressure was 805 lb and final flowing pressure 1,495 lb. Cities Service is drilling ahead to the Ellenburger objective, expected at about 10,500 ft.

★ Phillips Petroleum Compay has a new West Texas discovery well which flowed 975 bbl per day of 43.8 gravity oil through a small choke from the Devonian formation on its 7800-acre South Embar block in south central Andrews County.

The discovery well, No. 3-B Embar, flowed from 24 ft of perforations in the section 9346-9370 ft. Gas-oil ratio was 980-1. The nearest Devonian production is in the Block 11 field five miles west of Phillips new discovery. The wildcat is on the Cowden ranch in Section 5, Block 44, T-2N, T&P survey, 16 miles southwest of Andrews, Texas.

★ On the second drillstem test in the Ellenberger, the Texas Company's Sallie W. Ratliff No. 1, a joint operation with the Magnolia Petroleum Company in Ector County, West Texas, flowed at the rate of 100 bbl of oil an hour from perforations, 13,585 to 13,605 ft. Corrected gravity was 53.2. The wildcat is 4 miles north of Headlee field, the nearest production. It is 6 miles north of Odessa.

Summary of drilling activity for October.
(As compiled by Rinehart Oil News Staff)

States	New locations		Wildcat completions			Field completions			Junked & abnd.		Temp. abandoned		Abandoned locations		Current active wells	
	Wc	Field	Oil	Gas	Dry	Oil	Gas	Dry	Wc	Field	Wc	Field	Wc	Field	Wc	Field
Alabama	7	2	0	0	4	0	0	0	0	0	1	2	0	0	7	0
Arizona	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arkansas	10	44	0	0	4	28	0	14	0	0	0	1	0	1	13	20
Canada (Williston B.)	28	65	2	0	25	49	0	4	0	0	0	0	2	0	21	17
Colorado	68	56	3	1	57	21	3	13	0	0	2	0	2	3	55	59
Florida	2	0	0	0	0	0	0	1	1	0	0	0	0	1	2	0
Georgia	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Idaho	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kansas	71	245	19	2	63	131	14	64	0	0	0	0	0	2	58	314
Louisiana	51	284	2	1	31	167	29	46	1	2	0	6	0	13	63	256
North	22	156	0	0	16	115	7	17	0	1	0	2	0	6	18	56
South	29	128	2	1	15	52	22	29	1	1	0	4	0	7	45	200
Mississippi	20	21	1	1	26	17	3	6	0	0	0	0	3	2	14	34
Montana	16	19	2	1	17	11	2	1	0	0	0	0	0	0	30	28
East	4	5	2	0	1	2	0	0	0	0	0	0	0	0	8	10
West	12	14	0	1	16	9	2	1	0	0	0	0	0	0	22	18
North Dakota	10	38	2	0	15	21	0	4	1	0	0	0	0	1	11	20
Nebraska	28	11	4	0	15	11	1	3	0	0	0	0	0	1	19	20
Nevada	4	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0
New Mexico	21	67	5	3	7	47	18	7	0	1	1	3	0	2	40	131
Eastern	10	52	5	0	6	46	3	4	0	1	1	3	0	1	35	90
San Juan	11	15	0	3	1	1	15	3	0	0	0	0	0	1	5	41
Oklahoma	72	560	12	3	48	386	56	159	2	1	1	7	0	27	43	428
South Dakota	2	0	0	0	1	0	0	0	0	0	0	0	0	0	2	0
Texas	507	1,422	58	10	297	810	68	269	0	3	10	9	13	26	421	833
East Texas	37	54	4	0	18	38	10	11	0	0	0	0	0	3	29	110
Gulf Coast	38	112	3	3	29	67	5	20	0	0	0	0	0	1	37	88
North Texas	153	455	17	1	71	221	1	124	0	0	0	0	0	1	59	80
Panhandle	13	83	3	0	7	58	22	4	0	0	0	0	0	7	19	23*
South Texas	108	217	3	4	63	106	28	37	0	1	10	6	11	5	71	86
Border Co.	31	72	8	0	24	57	1	10	0	1	0	0	1	1	28	65
West Central	76	166	6	1	66	81	0	50	0	0	0	0	0	0	65	64
West Texas	51	263	14	1	19	182	1	13	0	1	0	3	1	8	113	330
Utah	7	2	0	0	3	0	0	2	0	0	0	0	0	0	27	5
Wyoming	36	82	4	0	20	54	1	8	0	0	4	2	3	2	61	84
Totals: Jan.	699	2,425	121	47	611	1,780	254	584	6	5	10	21	17	144	808	2359
Feb.	713	2,816	101	28	503	1,583	228	542	0	5	21	22	29	98	845	2362
March	975	2,945	115	42	585	1,866	242	605	0	6	27	33	16	69	950	2659
April	966	3,166	117	46	665	2,006	186	618	2	4	20	24	25	108	953	2665
May	879	2,727	92	35	600	1,762	170	478	2	2	29	21	13	92	945	2580
June	1074	2,978	110	42	704	1,759	250	524	4	2	36	59	35	113	1008	2640
July	1018	2,940	132	42	727	2,059	255	666	1	4	15	40	14	117	936	2361
August	887	2,880	111	38	734	1,848	226	616	5	5	17	20	31	83	872	2349
Sept.	916	2,940	107	38	715	1,907	232	608	10	8	23	40	27	82	902	2406
Oct.	960	2,918	114	22	634	1,753	195	601	5	7	19	30	23	81	891	2249
1954 total	9087	28,735	1120	380	6478	18,323	2238	5842	35	48	217	310	230	987	—	—

* Figure incomplete.

Courtesy Rinehart Oil Reports

OKLAHOMA

★ Completion of a test well by Toklan Royalty Corporation and Lone Star Producing Company in Stephens County, Oklahoma, has been announced. The new well has an initial production of approximately 75 bbl daily, after having been plugged back from a total depth of 8700 ft to the Pickens sand encountered at 6710 to 6790 ft. In addition to the horizon tested, the initial test well indicated production in 3 other horizons from 6350 to 6500 ft.

★ Plans for a test of deeper horizons in a wildcat location nine miles north of Chickasha were announced by the Rotary Development Corporation and Humphrey Oil Corporation of Dallas. The location of the deep test, No. 1 Coleman-Davis, is in the center of SW ¼ NW ¼, Section 20 T-8-N, R-7-W. Parker Drilling Company of Tulsa has the contract to drill to a depth of 13,500 ft.

CANADA

★ Cities Service will drill the Sabine No. 1 LSD 5, in section 33, township 37, range 18, W4th, Alberta Province. The test is a 9351-acre block and 8½ miles northwest of Cities Service's shut-in gas well, Hackett No. 1, and 10 miles northeast of the Stettler field. Proposed total depth is 5800 ft with the Viking and Basal sandstones in the Cretaceous, Mississippian limestones, and reef limestones in the Devonian as objectives. Canada-Cities Service and British American Oil Company are joint owners of the venture. Canada-Cities Service is to operate.

LOUISIANA

★ Pure Oil has opened a new Petit field in Bienville Parish in North Louisiana with the completion of the No. 1 J. B. Smith Unit. With casing perforated in the interval 7022-40, and flowing through a 20/64 in. choke, the well was tested at 238 bbl of 38.5 deg crude per day.

★ In Concordia Parish, the Bee Brake field was extended about a mile by the David Crow Trustee No. 1 Quinn. This Wilcox producer was finaled on the pump for a potential of 113 of 36.6 deg oil per day. Casing perforations were made at 6721-24.

★ In the southern part of the state, in Cameron Parish, the Fifteen Oil Company is completing its offset to the discovery well in the Grand Cheneir field. Drilled to a total depth of 12,020 ft, the new well is flowing through perforations 11,210-20. On drillstem test 5/16 bottom and ⅛ top chokes, the yield was of the order of one million ft of gas and 15 to 20 bbl of high gravity condensate per day.

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Exploration

ARIZONA

★ Completion of Shell Oil Company's Arizona wildcat, No. 2 East Boundary Butte in Apache County, Arizona, more firmly establishes Arizona as the nation's thirtieth producing state. The well flowed gas at a daily rate of 2,200,000 cu ft through a ⅜-inch choke from a plugged back depth of 4,884 feet. During a 13-hour test, it produced fluid at the rate of 32 BD, of which 11 barrels was oil, producing from the Pennsylvanian. The wildcat is located about 3½ miles west of the gas well completed last June at Boundary Butte No. 1, and about 8 miles southeast of Utah's Boundary Butte field.

UTAH

★ Shell Oil Company has announced that the company's Desert Creek No. 2 well, located approximately 15 miles southeast of Bluff, Utah, flowed 1128 bbl of oil per day, 2.8 per cent cut, on the basis of an 18-hr production test. The gravity of the oil is 40 degree. Production was established from the interval 5244 to 5320 ft following perforating and acidizing. The well is company's second attempt in the area. The first well, Desert Creek No. 1, located about ¾ of a mile to the southwest, was abandoned as a dry hole.

MEXICO

★ Discovery of a new oil field in Mexico is announced by Adolfo Ruis Cortines, president of Mexico. Pemex, the government oil agency, drilled the discovery well near Teculutla on the Gulf Coast. The well came in flowing 3000 bbl of oil daily through a ½-in. choke. The oil was described as 30 gravity with a paraffin base, the lightest ever found in Mexico.

SAUDI ARABIA

★ Discovery of a productive horizon hitherto unknown in the Middle East was announced by American Independent Oil Company. Oil was found in porous limestone at a depth of 6760 ft in an exploratory well being drilled for the joint account of American Independent and Pacific Western Oil Corporation in the Kuwait-Saudi Arabia Neutral Zone.

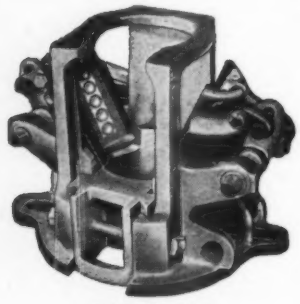
On a drillstem test the well flowed 25.6 gravity oil at an indicated rate of 2400 bbl daily. The company plans to core and drill ahead, after which further tests will be made. The discovery well is located on the so-called Wafra Structure in the west-central part of the Neutral Zone where Aminoil and Pacific Western at present have 15 wells producing oil from the shallower Burgan horizon at a depth of about 3500 ft. The new strike, at a depth of 6760 ft, opens up a productive limestone section that has not previously been known in the Persian Gulf area. The company plans to carry the well on down to the Arab zones, which are productive farther to the south in Saudi Arabia.

KANSAS

★ Barber County, in the southern part of the state, has a Viola discovery in the Aurora Gasoline et al No. 1 Gudeman. On a drillstem test the section 5158-70, porous Viola Lime, recovery was 780 ft of oil, 600 ft of which was clean. The well is located only 1½ miles north of the Oklahoma line.

★ Rine Drilling has a producer in the central part of the state in the Central Uplift area. The well, southeast of the Dunes field in Pawnee County, pumped 50 bbl per day on completion.

★ Cities Service's Voran No. 1, located in Kingman County, is to be drilled on a 3650-acre block 10 miles south of the city of Kingman. Nearest production is the Basil field 2 miles to the northwest. The well is projected to a total depth of 4650 ft and will test the Lansing-Kansas City, Mississippi, Viola, Simpson, Arbuckle limestones, sandstones and dolomites.



(Pat. Pend.)

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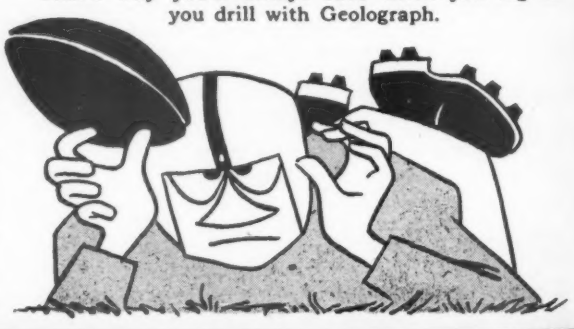

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Exploration

CALIFORNIA

★ Bandini Petroleum Corporation and Moriqui Exploration Company have announced plans to drill a joint venture wildcat 7 miles north of Shell Oil Company's discovery well in Railroad Valley, Nye County, Nevada. The well is projected to a depth of 7000 ft and will be known as Harris-Government No. 1, located on Sec. 25, T10N-R57E.

★ Seaboard Oil Company is preparing to spud a wildcat 2 miles east of Kettleman City on the edge of Tulare Lake. The well, Gibson No. 22G-22 will be located in the southeast quarter of Sec. 22,22-19, and will prospect for gas production between 4000 to 5000 ft.

★ Humble Oil and Refining Company has moved in to drill a new gas test about 4 miles northeast of production in the Beehive Bend field. Site of the new test falls on the Parrott Investment Company lease in Butte County. Designated as Parrott Investment Company lease No. 1, the wildcat is on Sec. 4, 19N-1W.

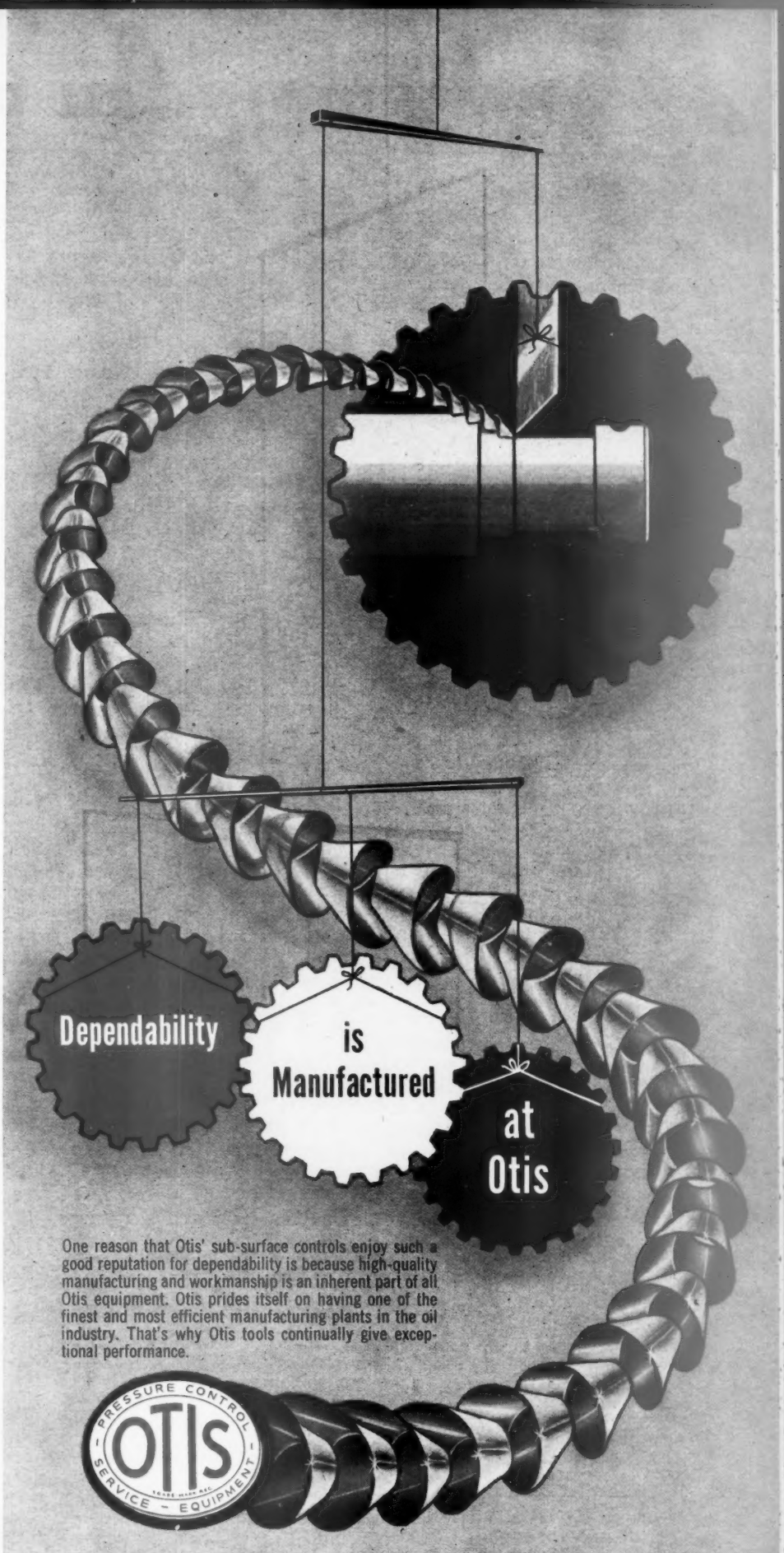
★ Exeter Oil Company has reported completion of a new deep zone discovery in the Midway-Sunset field. Initial production was at the rate of 1680 bbl daily, of clean 30 gravity oil, flowing through a 14/64 inch bean. The well is Murphy Fee No. 11, located on Sec. 28-32-24.

★ Los Nietos Company will drill a deep test two miles south of Guijarral Hills field in Fresno County. The wildcat is expected to go below 10,000 ft with the principle objectives of the deep test being the Allison and Leda sands.

★ CKM Oil Company has staked location for a wildcat in the Rosedale area of Kern County. The test, KCL No. 1 is on a 570-acre lease from Kern County Land Company, with the well site located 1 mile east of the Santa Fe Railroad Rosedale station. If successful, the wildcat could establish a new field between Rosedale production and Standard Oil Company's Lerdo field.

★ Richfield Oil Corporation has staked a location for a new Eocene test 1½ mile northeast of Eocene production in the Wheeler Ridge field. Located on a 4168-acre lease from Kern County Land Company, it will be the first deep test drilled northeast of the field since Richfield's original Eocene discovery in 1952.

★ Intex Oil Company is preparing to drill a wildcat on a 1600-acre lease between Antelope Hills and South Belridge. The site, Voight-Custodian No. 1-1 is located 1½ miles east of the Antelope Hills field.



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WHAT'S DOING IN DRILLING

TEXAS

★ The Howeth and Mason-Texas Eastern Production Corporation No. 1 Irma Mills, confirmation test to Drilling and Exploration's Melon area discovery, Frio County, has been completed for an Austin chalk oil well. Pipe was set on top of the chalk at a depth of 5465 ft and then the well was drilled to a total depth of 5807 ft, cutting an estimated 100 ft of fractured chalk. Well was treated with 5000 gal of acid and on test swabbed 62 bbl of pipe line oil with no water in 6 hours.

★ Cities Service has a ⅜ mile extension to the South Cowden-Ellenburger pool of Ector County in the completion of the joint-interest Foster "F" No. 1 for a potential of 1631 bbl of oil daily. The well, approximately 10 miles southwest of Odessa, is the third producer in the field and is the largest oiler completed to date.

The Railroad Commission potential was based on a 7-hour flowing test from open hole opposite the Ellenburger from 12,858 to 12,960 ft. A total of 476 bbl of oil went into the tanks during the test. Flow was through a ¾-in. choke, the flowing tubing pressure was 350 lb and the gas-oil ratio was 1270-1. Two rigs are running on the drilling units, with the TXL "N" No. 1 approaching the Ellenburger and running high. The other well has been located ⅜ mile southeast of Foster "F" No. 1.

★ Another well in the Dora Roberts Ranch area of Midland County, was reported in the completion of the Forest et al Dora Roberts C-1 No. 1 for a potential of 3571 bbl of oil daily. On test of 234 ft of Ellenburger pay from 13,082 to 13,316 ft, the well flowed 893 bbl of oil in 6 hours through a 1-inch choke with surface pressure of 700 lb. The gas-oil ratio was 1158-1.

★ The South Crews field of Runnells County has a fourth pay with the completion of the Humphrey No. 4 Clayton. Well was finaled in the King sand for a potential of 107 bbl, 43.7 deg crude, with a gas oil ratio of 260 to 1. Test was made through a quarter-inch choke with flow from open hole 2166 to 2171 ft.

★ Bankline Oil Company et al completed another discovery in the Tippett, East area of Northwest Crockett County at their No. 1-H-41 Renee Mayberry Forristal.

Well was finished for a calculated 24-hour potential of 345 bbl of 38.5 gravity oil from pay in the upper Wolfcamp at 5950-80 ft. The completion was natural. Flow was through a 14/64 inch choke. Tubing pressure was 1275 lb and casing pressure was 2300 lb. Total depth is 6246 ft with 7-in. casing cemented at 6242 ft.

MISSISSIPPI

★ The relatively new Bolton Paluxy Field in Hinds County west of Jackson has precipitated a minor boom with some 7 rigs running. The Stanford et al No. 1 Mashburn, west offset to the discovery has been completed as a 254 bbl per day oiler, 38 deg crude, low gas-oil ratio. Well was tested through a ⅛ choke flowing from perforations 9909-19 ft. At least 2 of the other wells have passed the pay zone of the discovery with no indication of commercial production but have indicated possibilities in the lower Glen Rose section. The field as developed represents the only Paluxy production in the state and thus seems to offer additional promise for the area.

AUSTRALIA

★ Western Australian Petroleum Pty., Ltd., will drill Rough Range No. 4 about 1700 ft due south of its Rough Range No. 1. Rig that drilled Rough Range No. 3, some 1000 ft northeast of the discovery well, will be moved to the new site when testing of the unproductive well is completed. Company meanwhile is preparing to drill its first test at Grant Ridge in the West Kimberly district.

MONTANA

★ In the Northwest Sumatra field of Rosebud County, the Kincheleo No. 5-A has been completed as a pumper from a total depth of 4717 ft. With 5½ inch casing set at 4656 feet and perforated 4583-4615, well pumped at an intial rate of 472 bbl per day.

NEW MEXICO

★ Continental No. 2 Bell Lake Unit has been completed as a gas distillate discovery in Lea County. Tested through a 11/64-in. choke, the well flowed 140 bbl of 55.8 deg distillate and over 11 million cu ft of gas per day. Perforations are in the Wolfcamp from 12,635-65. This well suggests at least a one mile northward extension to the discovery.

★ Sinclair Oil and Gas Company has completed its No. 7 Lee Whitmore tract B, Lea County. The well flowed for a calculated potential of 512 bbl per day.

Production was from perforations at 12,544 to 12,648 ft. Gas-oil ratio was 481 to one, and gravity was 44.8 deg. Total depth was 12,654 ft. with 7-in. casing at 12,653 ft.

OKLAHOMA

★ Completion of another East Noble Pool development well, the pool's third and largest is announced. The Honeymon Drilling et al No. 1 Uri was tested for 2 hours and yielded 175 bbl of 37 deg crude. Completion is in the Tulip Creek from 7912 to 7918 (perforated) and test was made through a 52/64-in. choke with flowing tubing pressure of 100 lb.

★ In Lincoln County, Globe Oil has a good well from the Skinner Sand. The No. 1 Moore in the Mount Vernon field tested 30 bbl of oil an hour from perforations at 4349-53 through a 14/64-in. choke. Well was drilled to a total depth of 4403 with 5½ inch suspended two feet off bottom.

★ Stanolind Oil and Gas has reported the completion of its No. 2 Crawford in Garvin County from a plugged back total depth of 9800 ft. Well was perforated in the Hart zone and flowed 352 bbl per day through a 28/64 choke with a tubing pressure of 100 lb.

Rotary Rigs Operating in Oil Fields of United States and Canada*

	Oct. 25	Nov. 1	Nov. 8	Nov. 15
Pacific Coast	132	131	136	142
Oklahoma	283	289	296	316
Kansas	154	156	159	175
Rocky Mountains	251	241	255	251
Canada	163	171	191	195
Ark-La-Tex	175	177	185	186
West Texas and New Mexico	449	443	453	497
Gulf Coast	530	520	528	548
Illinois	131	134	137	148
North Texas	288	280	282	301
Total	2556	2542	2622	2759

*As reported to the American Association of Oilwell Drilling Contractors by Hughes Tool Company

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Notice the inexpensive sub-structure. In normal installations, **no** sub-structure is required.

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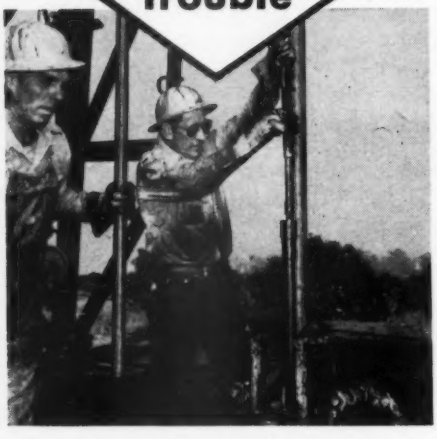

insure with Hydro-Test

It is doubly important that you prevent tubing failures with Hydro-Test when running a parallel string. Hydro-Test checks your tubing, threads, couplings and the body of the pipe under hydrostatic pressure, in made-up position, while tubing is being run in the well. Both the 2½ inch and 1¼ inch tubing is tested alternately as the stands are made up.

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PHONE: 404-466

Drilling

CANADA

★ Union Oil Company and Hudson's Bay Oil and Gas Company have completed another high-volume oil producer in the South Sturgeon Lake area in Northwestern Alberta, Canada. The new well, Liberal 5-33, located 4½ miles west of Liberal 15-31, which came in recently flowing at a rate of 4500 barrels per day, was placed on production over last weekend and on a 6-hour test flowed at a rate of 1200 bbl of clean oil per day. Production is from the Devonian Reef, from a perforated interval 8604 to 8618 ft. Operators are preparing to start two additional wells in the same block.

WYOMING

★ Sinclair Oil has dually completed it's Happy Springs Unit No. 30 in Fremont County from the Lakota and the Phosphoria. Well swabbed at a 375 bbl per day rate from the shallower zone, 39.3 deg oil, and a 233 bbl per day rate, 32.3 deg crude, from the lower. Completion was through perforations with gas-oil ratio nominal.

★ In Natrona County, Forrest Oil has an apparent confirmation test in its No. 2 State 22-2 Unit. Offsetting about ½ mile the thousand-barrel discovery well, the No. 2 tested the interval 6663-6708 with flow through a ¼-in. choke of 50 to 100 bbl per hour rate from a Cretaceous zone.

★ Continental Oil, in its shallow Circle Ridge field, Freemont County, has completed the No. 37 Shoeshone 66 at a total depth of 729 ft. The well pumped initially 389 bbl of 22.5 deg crude and 43 bbl of water from perforations in the Embar zone.

CALIFORNIA

★ Universal Consolidated Oil Company, at last report, was making a formation test in the third well on 20th Century-Fox studio property. The two previous wells have been shut-in since completion, awaiting the installation of handling facilities.

★ Basin Oil Company completed Standard Brick No. 2 on its North Inglewood lease. Drilled to a total depth of 8590, the well came in producing at a rate of 160 bbl per day of 28.3 gravity oil from the Zins Zone. The company has only one other well producing from this zone and plans to skid the rig to drill an immediate follow-up.

★ Ohio Oil Company is preparing to drill F. E. Smith-Government No. 3 on Sec. 23, 30-21 in the Belgian Anticline field. The well will be an easterly offset to the discovery well completed several weeks ago for a reported 475 bbl per day of 32.5 gravity oil.

The most flexible, least expensive

method of pumping oil wells is the

KOBE Free Pump System

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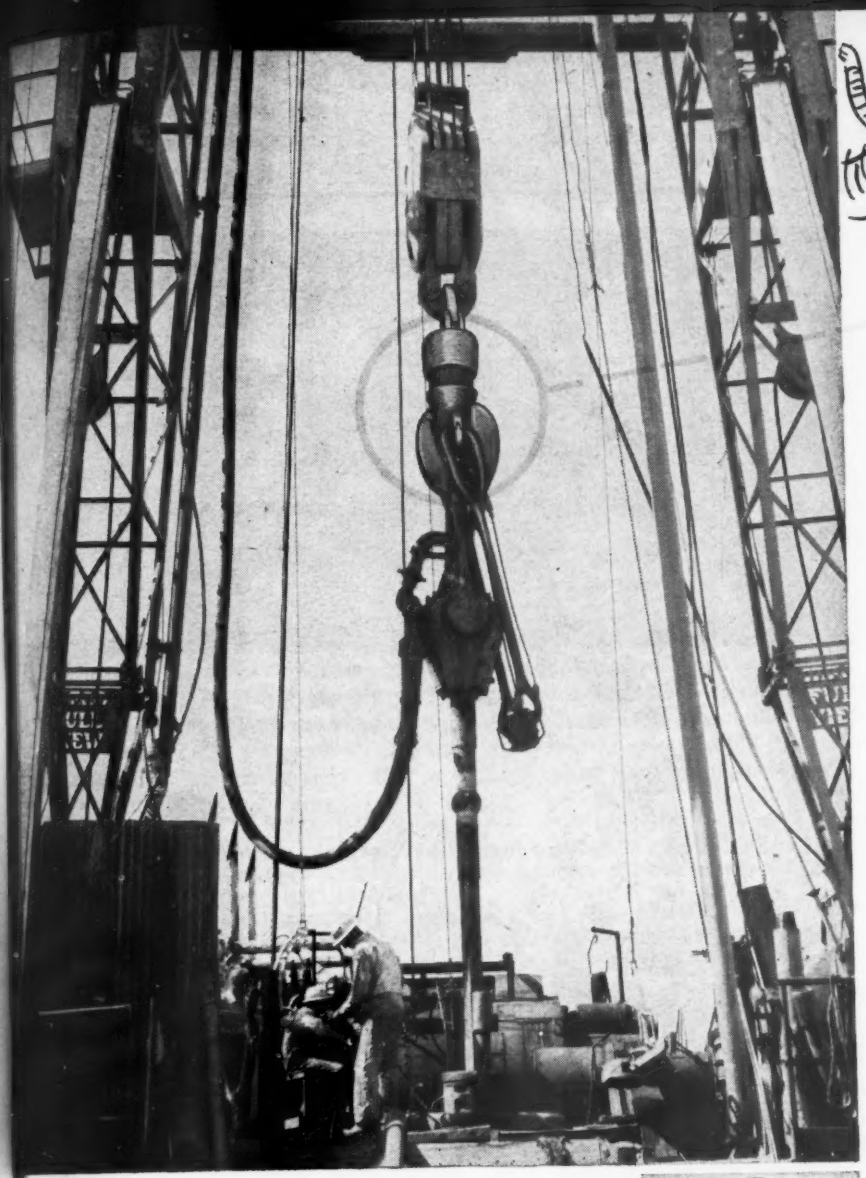

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Fewer Parts, Less Maintenance
Shorter Length, Streamlined Design
Direct Connection to Popular Blocks

The new HYDRA HOOK combines outstanding features of previous Web Wilson Hooks with many modern improvements, such as: Elimination of a Top Bearing; a Completely Packed-Off Body to prevent oil leakage and keep the "dash pot" action at peak performance.

The 150-Ton HYDRA HOOK (illustrated at right) is a full 8 inches shorter and 1,200 pounds heavier than its predecessor. A dream in streamlining, its additional weight and perfect balance make even the lightest traveling blocks fall fast and true.

AVAILABLE NOW: the 100-Ton, 150-Ton and 250-Ton Sizes.
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XUM

RUNNING TOUR with MEN in the INDUSTRY

▸ **W. M. Paggi** has been promoted to regional superintendent, operating department, at Houston, Texas, for Sun Oil Company. Paggi formerly was assistant superintendent at Houston. He succeeded **J. O. McPherson,** veteran Sun man who retired recently after more than 45 years of company service. Paggi, who has been with Sun 21 years, will supervise drilling and producing operations in all operating department areas west of the Trinity River in Sun's Gulf Coast division.

▸ **R. D. Sloan,** Denver, Colorado, has been named division manager of The Carter Oil Company's western division, effective January 1. He will replace **George E. Wagoner** who has been appointed exploration advisor of International Petroleum Company Ltd. at Coral Gables, Florida. Sloan started work for The Carter Oil Company as geologist in Tulsa in 1934, and he served as district geologist, division geologist, and division exploration manager before becoming western division exploration manager in 1948. Wagoner was graduated from the Colorado School of Mines, Golden, with a BS in geological engineering. He began his oil industry career in 1930 with Humble Oil and Refining Company's Geological department, then joined Carter as seismograph computor. Wagoner was made Carter's southern division exploration manager at Shreveport, Louisiana, in 1946 and became manager of the company's western division at Denver in 1953.

▸ Secretary of the Interior **Douglas McKay** has named **J. V. Dunbar** of Dunbar Drilling Company, Denver, Colorado, newly elected president of the American Association of Oilwell Drilling Contractors, to the National Petroleum Council. Dunbar succeeds **K. L. Kellogg** of K. L. Kellogg and Sons, Compton, California, both as a member of the council and as president of the American Association of Oilwell Drilling Contractors.

▸ **Victor V. Horner,** Denver, Colorado, has been named a research engineer in the drilling methods section of The Carter Oil Company research laboratory. Horner, who was graduated from the University of Tulsa with a BS in petroleum engineering in 1935, joined Carter as a member of an inventory crew and was later district petroleum engineer. For the past nine years he has served as division engineer and secretary-treasurer for two major petroleum firms.

H. N. Mallon, third from left, pesident of Dresser Industries, Inc., congratulates Willard M. Johnson, president of the Magnet Cove Barium Corporation, on the success of Magcobar's formal opening of its Houston headquarters. Others in the picture are (left to rigbt) R. E. Reimer, vice president and treasurer, Dresser; J. B. O'Connor, executive vice president, Dresser; Mallon; Johnson; and Orien Van Dyke, vice president, Magcobar.

▸ **E. L. Anders, Jr.,** consulting petroleum engineer, has announced the opening of offices at 231 Windsor Hotel, Abilene, Texas.

J. W. Glass, Jr.

▸ **Julian W. Glass, Jr.,** was named president of the Panhandle Producing Company, which has headquarters in San Antonio, Texas.

Glass has served as vice president and director for the corporation since the death in 1952 of his father, the first president and organizer. Other officers and directors are **F. Wallace Hall,** vice president, Amarillo; **Irene Stimson Cox,** secretary-treasurer, San Antonio; **Eva Payne Glass,** Nowata; and **A. A. Eason,** San Antonio.

▸ A reorganization of Shell Oil Company's mechanical engineering department for exploration and production into separate gas, technological, and mechanical engineering departments has resulted in several appointments. **W. B. Golush,** formerly head office gas representative, will be manager of the gas department; **J. T. Jordan,** formerly chief technologist in New York, will be manager of the technological department, and **J. D. Goodrich,** formerly production manager of the North Texas division of the Tulsa area, will be manager of the mechanical engineering department.

▸ Bates and Cornell, composed of **Fred W. Bates, Jay B. Wharton, Jr., Robert R. Copeland,** and **Mark W. Mitchell,** petroleum geologists; and **Drew Cornell** and **Paul Montgomery,** petroleum engineers, will terminate their partnership as of January 1, 1955. The former partners have announced they will operate as individuals, and all of their previous functions as consultants, and as an independent operator, will continue. The same technical and field staff will be maintained. A company will be formed for the purpose of operating properties for themselves and others.

▸ New chapter officers have been elected by the American Association of Oilwell Drilling Contractors. Chairman of Ark-La-Tex is **R. W. Waddell;** Corpus Christi, **C. F. McCauley;** California, **S. I. Williams;** Denver, **R. L. Nicholas;** Casper, **Ray A. Sing;** Fort Worth and Dallas, **J. Mark Gardner;** Houston, **H. J. Chavanne;** San Antonio, **Gordon W. Johnson;** Kansas, **Collis P. Chandler, Jr.;** South Louisiana, **W. A. Grapes;** North Texas, **Frank M. Denman, Jr.;** Tri-State, **George H. Pappas;** Permian Basin, **E. G. Durrett;** and Tulsa, **J. L. Stauss.**

▸ **R. W. Andrus, Jr., L. A. Beecherl, Jr.,** and **H. J. Wetegrove** have announced the opening of offices as petroleum and natural gas consultants. Headquarters are in the Wilson Building, Corpus Christi, Texas. Andrus, Beecherl and Wetegrove, registered professional engineers, will specialize in south Texas and Gulf Coast areas.

V. V. Horner

G. E. Wagoner

R. D. Sloan

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. . . pack a load?
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. . . and dig out fast?

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TYPE 'B' BRIDGE PLUG

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Continental Oil Company

P. A. MILLS
Moody Engineering Company

C. E. REISTLE, JR.
Humble Oil & Refining Company

C. V. MILLIKAN
Amerada Petroleum Corporation

▸ **Dr. Rein de Wit** has transferred from the position of chief geologist, Canada to staff geologist, northwest division of Sohio Petroleum Company. De Wit a native of Batavia, Java, joined Sohio in March, 1952.

H. D. Fox will replace de Wit. Fox, a graduate of Union College and the University of Wyoming, joined Sohio in August, 1953.

Vernon E. Holmes has transferred to the northwest division, replacing **Walter L. McCloy, Jr.,** deceased, as superintendent, production operations. Holmes joined Sohio in December, 1943, and has held positions of petroleum geologist, district superintendent, manager of industrial relations, assistant division superintendent, and since March, 1953, division superintendent of Gulf Coast division.

▸ **H. E. Menger** has been named division geologist for Monterey Oil Company. **Coleman C. Case** has been appointed division landman and assistant secretary in the Mid-Continent area.

▸ **Melvin G. Oxsen** has joined the staff of Lion Oil Company's production and exploration district office in Denver, Colorado, as a geologist trainee.

Robert C. McCain has joined Lion Oil Company as geologist in the Casper, Wyoming district office. McCain is a graduate of Colorado School of Mines.

▸ **Robert W. Verkins** has been transferred from Tulsa, Oklahoma to Billings, Montana where he wil be chief scout of The Carter Oil Company's northern division.

M. M. Mulholland, district geologist at Grand Rapids, Michigan has been promoted to staff assistant at Mattoon, Illinois.

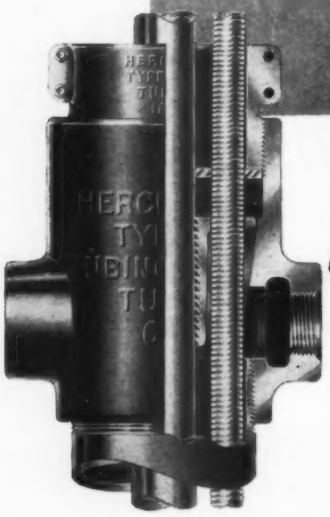
▸ **Roger C. Hamil, Jr.,** has been appointed vice president in charge of the oil and gas department of the Victoria Bank and Trust Company. Hamil was district petroleum engineer for Humble Oil and Refining Company in Brookhaven, Mississippi.

▸ **J. G. Jackson,** petroleum engineer in Humble Oil and Refining Company's Southwest Texas division office has been promoted to senior petroleum engineer. **C. J. Wooley** has been transferred to the petroleum engineering division, Houston, Texas office, as supervising petroleum engineer. **D. M. Stewart** replaced Wooley. Stewart was in the Houston office.

IN MEDIUM DEPTH WELLS

HERCULES "TYPE J-5-R" AND "RC" TUBING HEADS

DESIGNED FOR USE WITH REDA PUMPS



Designed for medium depth wells. Will suspend 5000 feet of 2" or 2½" Tubing or a proportionate amount of 3". Available in casing sizes from 5½" OD (which will suspend 2" or 2½" tubing only) to 7" OD which will suspend 2", 2½" or 3" tubing. Pressure cast steel body hydrostatically tested to over 4000 psi. 2" LP outlets furnished. (3" optional). Approximate over-all height, 14½".

Both heads feature the positive aligning hinged slips (which allow the electric cable to pass through the slips close to the tubing) and the overhead packing arrangement which packs off the tubing and electric cable simultaneously. The packing arrangement in both heads is tested to 2000 psi.

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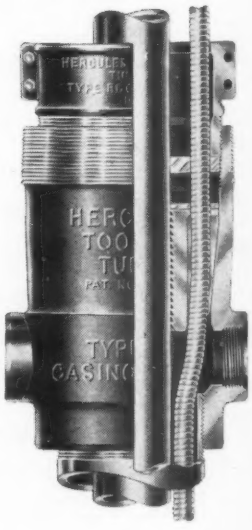
Built to support the weight of 10,000 feet of 2", 2½" or 3" Tubing, 5,000 feet of 4", or 4,500 feet of 5½" Casing. Available in casing sizes from 6⅝" to 9⅝" OD. 3" side outlets furnished. Pressure cast steel body tested to 4000 psi. Approximate over-all height, 23".

IN DEEP WELLS



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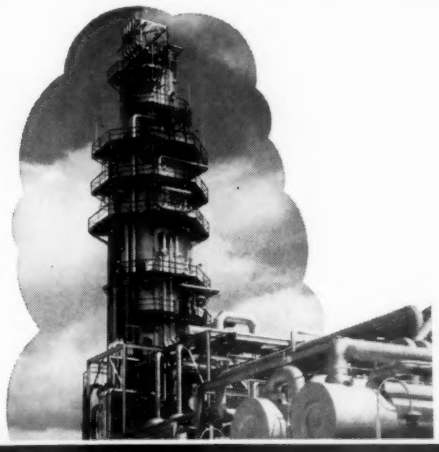

At Fawley, England

Monel gives Esso a high level of performance in fractionating tower tops

Fitting Monel internals in Monel-Clad top of fractionating tower. Top sections of fractionating towers are protected from corrosion by Monel cladding. In this area, distributor pipes, trays, bubble caps and fittings are solid Monel.

About two years ago, the two distillation units in Esso's Fawley refinery went on stream. Designed by Standard Oil Development Company and constructed by Foster Wheeler, Ltd., it is the largest refinery ever built at one time anywhere.

One unit is a single-stage atmospheric tower. The other is a two-stage atmospheric and vacuum unit. Both use Monel® in the top sections . . . Monel trays, Monel bubble caps, Monel pipe, Monel-Clad linings.

When examined after the first year, the Monel in the single-stage unit was still in "as new" condition. Today, both atmospheric towers are breaking down corrosive crudes originating in Arabia, Iraq, and other sections of the Middle East.

Reasons for choosing Monel

For one thing, Monel costs less per pound than other alloys able to withstand the corrosion. Furthermore, it requires no heat treatment since its corrosion resistance is not impaired by welding. Then, too, Monel is easy to form . . . lends itself well to lining.

But the most important reason for choosing Monel is the way it stands up to the various corrosives found in upper sections of fractionators.

In this area, reflux pushes vapor temperatures down to about 250°F. Walls and trays cool vapors further. As they go below the dew point, aqueous hydrochloric and sulfuric acids form in the condensate. Corrosive salt compounds may be present also.

The record of Monel in resisting all these forms of corrosion when temperatures are under 500°F., is outstanding . . . not only in atmospheric towers, but in overhead condensers, too.

If your next inspection of either type of equipment shows corrosion, why not investigate the use of Monel? A letter addressed to Inco's Corrosion Engineering Section will bring full information regarding the application of Monel in this corrosive service. No cost or obligation, of course.

The INTERNATIONAL NICKEL COMPANY, Inc.
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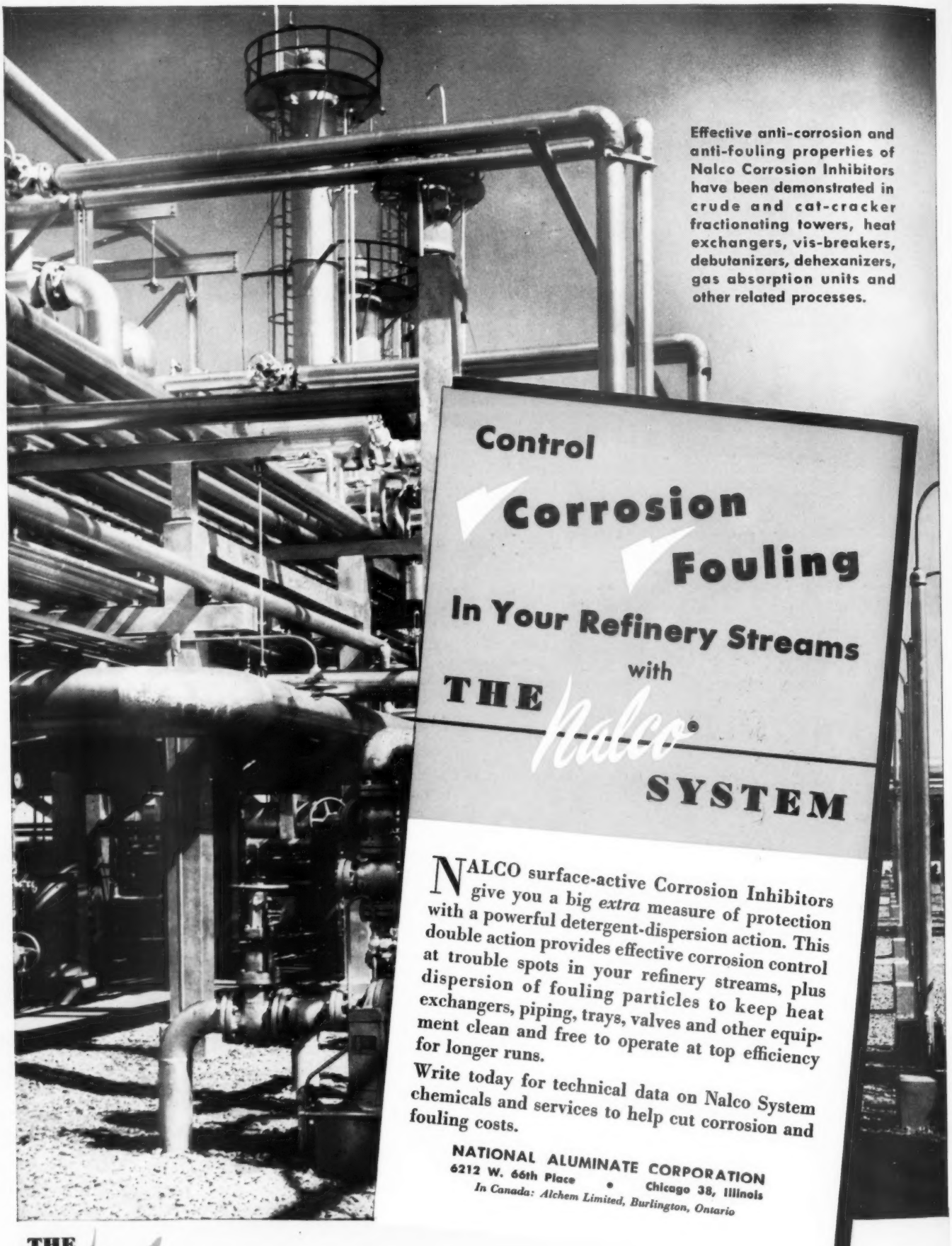
INCO TRADE MARK Nickel Alloys

Monel...for minimum maintenance



Effective anti-corrosion and anti-fouling properties of Nalco Corrosion Inhibitors have been demonstrated in crude and cat-cracker fractionating towers, heat exchangers, vis-breakers, debutanizers, dehexanizers, gas absorption units and other related processes.

Control Corrosion Fouling In Your Refinery Streams with THE Nalco SYSTEM

NALCO surface-active Corrosion Inhibitors give you a big *extra* measure of protection with a powerful detergent-dispersion action. This double action provides effective corrosion control at trouble spots in your refinery streams, plus dispersion of fouling particles to keep heat exchangers, piping, trays, valves and other equipment clean and free to operate at top efficiency for longer runs.

Write today for technical data on Nalco System chemicals and services to help cut corrosion and fouling costs.

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THE Nalco SYSTEM • Serving the Petroleum Industry through Practical Applied Science

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The Automotive-Oil Industry 'Siamese Twins'

Early in November the Fuels and Lubricants Activity (Division) of the Society of Automotive Engineers held its 11th annual meeting in Tulsa, Oklahoma, to talk over all or most of the always-expanding problems common to the two industries. Now, this SAE bunch are about the toughest, hardest-headed, most practical gang of engineers in the whole engineer category; they don't give a paper and then shut off talk before anyone can disagree; they do not consider harmony within the ranks as desirable so long as differences of opinion exist — which length of time will be — from now on.

This meeting, more than any we have attended in a mere 27 years, illustrated and proved the inseparability of the two industries so far as fuels and lubricants, and the problems multitudinous that attend their manufacture and use, are concerned. 'Way back, we remember certain refiners who directed the operations of their plant in terms of the demands of the customer; they found out what the customer wanted, then set their controls to produce those products as nearly as possible. Nowadays that is typical procedure with most refiners; only a few of the smaller ones have failed to assume that motivating principle in refinery operation. Gone are the days when the refinery manager made what he wanted to make, and it was up to the sales department, the "peddlers," to sell the products if, and how, they could.

Yet we still must remember, and be governed by these principles — that the needs of automotive equipment are the MUSTS that shall control refinery operations; and in turn the limitations of rapidly advancing technology of petroleum refining must be controls and spurs alike to the designers of automotive equipment, in their demands on the properties of these same fuels and lubricants. Neither product can operate for a second without the other — Yet much too often in the past we have forgotten just that simple, axiomatic fact.

★ ★ ★

Socony's Refinery Sold

A landmark passed in the Pennsylvania-New York-West Virginia oil industry, cradle of the world industry, in the sale of the old and justly famous Olean, New York, refinery of Socony-Vacuum. Built by the then "independent" Vacuum Oil Company 'way back when', (in the 1870's) this plant has been one of the foremost leaders in the development of technology of the Penn-grade oil business. Now, comes decline in the supply of the desired grade of local crude. Socony announced last May that the plant was up for sale. C. J. Simpson Drilling Company of Dallas, Texas, bought property and will dismantle and either sell the equipment or ship it to Cuba where Simpson has oil interests. The plant staff to the number of 130 have accepted company offers of employment at its new refinery, Ferndale, Washington, which will mean some 500 people will trek westward — but hardly a la 1849'ers.

★ ★ ★

Thou Shalt—Thou Shalt Not

The pitiful spectacle of official Washington as it struggles to free itself from the Slough of Despondency of the 1933-1953 era, is an amusing (?) travesty or an unamusing tragedy. To wit: General Services Administration owns a magnesium plant at Velasco, Texas, wants to sell it, the federal government being no longer in the magnesium producing business — until World War III. Desirable — to sell it to recover a fraction of the overburdened taxpayers' money invested therein. 'Long comes Dow Chemical, offers to buy it —at a mere $13.5 million, still a goodly portion of the tax money invested. Trust busters of the Department of Justice (*their* word) block the sale, on the grounds that a monopoly *might* be established. Meanwhile, the taxpayer still groans under the overload; *no* magnesium is being produced there to lighten the weight of our planes, Saberjet 100, etc., yet the taxpayer *might* be gypped a few hundred thousands of 39-cent dollars (insert your own quotation as of the day you read this, if you do) so the stove-pipe-hatted prohibitors refuse to allow the sale; also at the same time if the sale does not go through, hundreds of thousands of those ??¢ dollars will be spent in "mothballing" the plant that will produce nothing, as of late experience; will deteriorate until it is worth nothing, in a few years. *All* the potential advantages are to be lost just to see that no trust operation violates the pure (?) spirit of the Law.

Truly, for an intelligent person, the peregrination of the official mind are beyond comprehension!

Wood Preservation

Treat a piece of wood with a solution of one chemical — then treat it with a solution of another chemical — Result—deposition of a reaction product of two chemicals that is modestly soluble in the wood, yet protects it for a great number of years from rot and decomposition by water, air, etc.

This is the latest development to come out of the Forest Products Laboratory, Madison, Wisconsin. (See report, How to Treat Fence Posts by Double Diffusion). For example, R. H. Baechler stands posts in a barrel of copper sulfate solution. Then he stands them in another barrel of sodium chromate solution. The copper sulfate penetrates the wood fibers, leaves $CuSO_4$ therein. The sodium chromate comes along in the second step, reacts with the copper to form copper chromate, which is strongly resistant to decay by water and the insects, bio-organisms, etc. therein. Copper chromate destroys wood-destroying fungi, insects. Cu-chromate is poorly soluble, rather permanent even in wood in contact with "leaching" water, such as refinery cooling towers.

Redwood is used all but universally in refinery water cooling towers; decay-resistant, but susceptible eventually to the leaching action of the water that removes the protective materials that prevent decay, after which the redwood is open to attack —delignification is the term employed, it seems. Pine posts show four-to-five times the service life of non-treated posts. Refinery cooling towers have shown several times the life of untreated towers, in this fashion. Maybe this idea will work — looks much like it. How about trying it?

★ ★ ★

New 'Ultrasonic' Lubricants

Southwest Research Institute scientists have made base stocks for jet engine lubricants that are expected to withstand the extreme heat of these engines, says "Charley" Raley, SRI chemist who has spent two years developing these materials for the U. S. Air Force; products may be in commercial production soon, Raley says. The 400 F temperatures jet engines throw on lubricants is too high for petroleum hydrocarbons; a number of the products from this research can withstand 500 F temperatures, it is understood. The only data on their composition is — phosphoric acid derivatives.

XUM

Sun Oil Company Puts New B&W "CO" BOILER On Stream at Toledo

SUNOCO

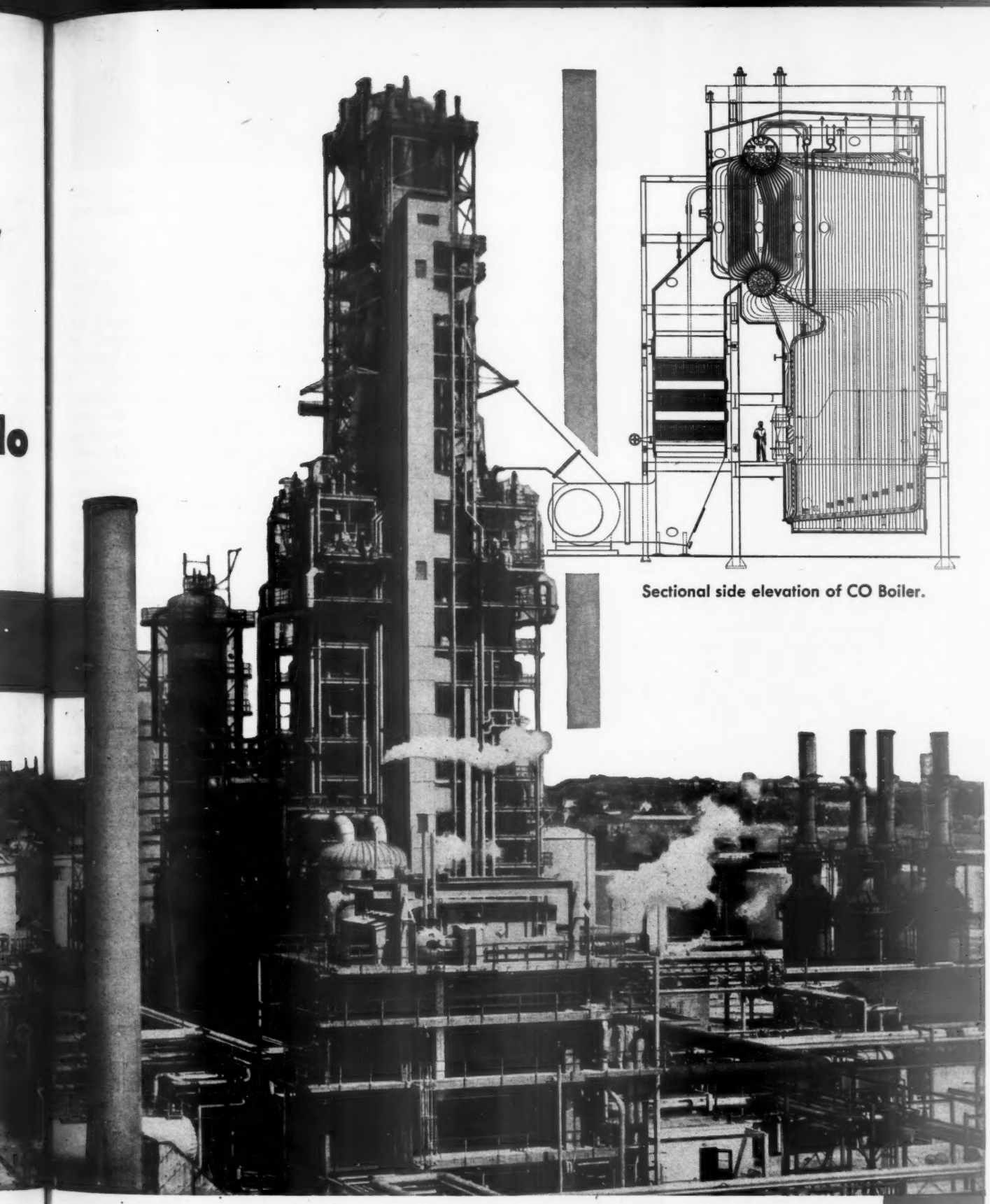
Waste heat at Sun Oil Company's Toledo, Ohio, refinery is being put to work to generate some 50,000 pounds of steam per hour. Add this to the 140,000 lb per hour generated from conventional fuels, and the total output of this B&W C O Carbon Monoxide Boiler is 190,000 lb per hour; steam to run compressors and other "cat cracker" auxiliaries efficiently.

When the catalytic cracking unit is on stream, the CO Boiler is fired with the exhaust gas from the catalyst regenerator in combination with fuel oil or refinery gas. The sensible heat and combustible carbon monoxide and any unburned hydrocarbons in the catalytic gases, exhausting from the regenerator of the cracking unit at a rate of 150,000 lb per hour, are used to produce 50,000 lb of steam per hr in the CO Boiler, instead of being expelled as waste gas. When the catalytic cracking unit is shut down, the CO Boiler, oil-fired, is available to operate as a conventional boiler, supplying steam whenever it's required.

Sun Oil has spent well over $1,000,000 in order to improve the surrounding atmosphere as much as possible by eliminating smoke and recovering valuable heat otherwise lost. This fuel saving is expected to amortize the investment in approximately four years.

This major stride in "putting waste heat to work" is the result of close cooperation between Sun Oil Company, Gilbert Associates, and The Babcock & Wilcox Company. Confidence in this project has resulted in the ordering, by Sun Oil Company, of two additional boilers from B&W for burning waste catalytic gases.

There are now three CO Boilers in operation—all Babcock & Wilcox. Let us discuss with you the working advantages of the CO Boilers and give you additional details. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.



Sectional side elevation of CO Boiler.

General view of Houdriflow Catalytic Cracking Unit at Toledo. B&W CO Boiler is in foreground.

BABCOCK & WILCOX

BOILER DIVISION

C. A. Schwartz, Caska Corporation, presided in morning; E. C. Greco, United Gas Pipe Line, spoke on corrosion.

Water treating was discussed by C. W. Brown of W. H. and L. D. Betz; Charles W. Bird, Bird-Archer; M. C. Forbes, Aquatrol Inc. W. S. McAllister, Warren Petroleum, was moderator for the panel.

Natural Gasoline Men Discuss . . .

Testing, Corrosion, Safety, Water, Petrochemicals

ARCH L. FOSTER*

AVAILABILITY of raw materials, natural gas and propane, relatively inexpensive space for plant, and facilities for expansion are some of the factors that determined the construction of a petrochemical plant at Longview, East Texas. These statements were made in a paper written by H. H. Imray, vice president of Texas Eastman Company, a division of Eastman Kodak Company, and delivered by J. H. Parker of the same company before the regional meeting of the Natural Gasoline Association of America at Tyler, East Texas, October 29.

Probably of greatest immediate importance in the meeting was an Information Panel on water treating. C. W. Brown of W. H. and L. D. Betz Company discussed the conditioning of engine jacket water; M. C. Forbes, Aquatrol, Inc., led off with some salient facts about the economics of water treating, and Charles W. Bird pointed up the requirements for maintaining suitable boiler water. W. S. McAllister of Warren Petroleum Company officiated as moderator and presented the questions showered on the panel by the men attending the meet.

Attention-arresting and warningly informative were the talk and demonstrations of dangers, inherent in the operation of any plant equipment, caused by the presence of static electricity that may cause extremely disastrous explosions and fires. G. M. Kintz of the U. S. Bureau of Mines Safety Division, Dallas, Texas, branch, showed how these developments may come about in a manner that is not readily understood by the majority of non-technical people in the industry. Contact between two non-conductor materials, or a conductor and a non-conductor, may set off an explosion by an air-gas mixture that may be nearby, caused by slow leakage of inflammable vapors into the air. A running belt may generate several hundred volts of static charge that may "leak off" onto or into a conductor or non-conductor, and cause an explosion in a container for hydrocarbon liquids or vapors.

Propane is first cracked thermally under heat and pressure to produce propylene and ethylene, which intermediate is employed to make a large number of organic chemicals, J. H. Parker outlined. A mixture of hydrocarbon with air or oxygen is burned partially to form so-called "synthesis gas," largely now to obtain the hydrogen. This hydrogen is employed to reduce various aldehydes to their corresponding alcohols for solvents and as intermediates for many other chemicals. Polyethylene is one of the important products that will be in large production in the near future at Longview and which goes into an exhaustive list of products of all sorts. In addition to making octyl alcohol and iso-butyl alcohol the Longview plant also makes 100 per cent, that is, water-free alcohol. Iso-octyl is used as a plasticizer and iso-butyl as a solvent for many chemical operations and reactions, Parker stated.

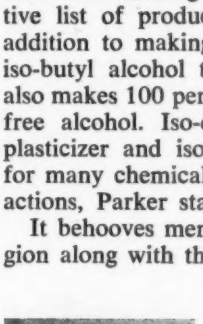
It behooves men to carry their religion along with them into their every day business lives. This was the gist of an attention-holding talk by J. Gordon Peterson, industrial chaplain for Dearborn Stove Company, Dallas. He showed how the simplest methods of fair play and honest dealing react to the betterment of all concerned.

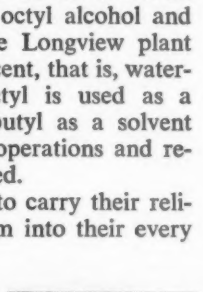
Split-stream testing of gas condensate wells can be executed in much less time with very rigid control of temperature and pressure and, when properly employed, will obtain representative samples of the liquid and gas phase constituting the full well stream composition in a method sufficiently accurate for all practical and engineering purpose, said W. A. Frier of Southern Petroleum Laboratories, Houston. The relative amount of liquid condensed at any point in a gathering system is a direct function of pressure and temperature at that point. Instead of taking the entire well stream through a separator equipped with heater, liquid, and gas measuring devices, many operators now draw off an aliquot portion of the stream of both liquid and gas into a portable, miniature separator with elaborate sampling and testing devices "built in," resulting in a considerable saving in both time and cost. A sampling lubricator is installed in a sampling loop or at the top of the Christmas tree; on one end is a sampling tip and on the other end a piston which is forced down by any convenient pressure, such as gas, to drive the tip down into the gas-liquid stream to collect the sample.

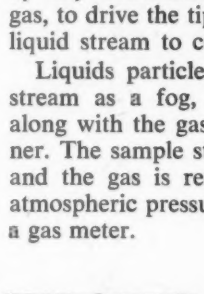
Liquids particles are present in the stream as a fog, and are picked up along with the gas in a uniform manner. The sample stream is refrigerated and the gas is reduced to essentially atmospheric pressure and measured by a gas meter. * * *

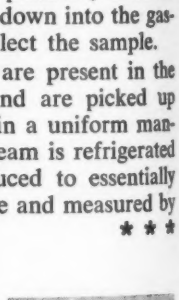
*Editor Refining and Petrochemicals Edition.

EXCLUSIVE









H. H. Beeson, Magnolia, presided at the afternoon session; J. Gordon Peterson, Dearborn Stove; J. H. Parker of Texas Eastman, and G. M. Kintz of the Bureau of Mines, spoke on religion, petrochemicals, and safety, respectively.

Syndet* Manufacture From Petrochemicals

The sodium salt of sulfonated dodecyl benzene, the alkyl aryl type, makes up to 80 per cent of all petroleum based detergents

CORNELIA T. SNELL
and
FOSTER D. SNELL

PETROLEUM-based synthetic detergents — or more briefly, syndets — made little headway until the early 1940's, when it was found that building with massive amounts of sodium tripolyphosphate made them effective washing agents for cotton goods. Before that, petroleum-based anionics had been applied successfully by the textile industry for a multitude of uses, wetting-out agents in dying, addition to chlorine bleaching in kier boiling, detergents in desizing, etc. These uses — individually and in the aggregate — are small compared with the household market. A collateral effect of incorporation of effective builders was to give products which were competitive with soap, cost-wise. These syndets then entered the household field, where their advantages over soap in hard water made their acceptance widespread.

During the war, raw materials for petroleum-based syndets were short, the production was largely required for the armed services, and practical realization of the potentialities of syndets was impossible. Post-war production of alkylate, sulfuric acid, and polyphosphates was stepped up. The net result was a tremendous increase in production of active agent for syndets as shown in Table 1.

*Syndet is the coined word signifying "Synthetic Detergents."

TABLE 1. Production of organic surface-active agents (from U.S. Tariff Commission Data) units of 1000 lb

Year	Petroleum-based	Other	Total
1943	51,538	48,445	99,983
1944	74,234	78,402	152,636
1945	79,004	105,438	184,442
1946	99,813	142,361	242,174
1947	112,687	178,474	291,161
1948	177,737	196,978	374,715
1949	232,721	196,635	429,356
1950	371,602	286,268	657,870
1951	502,567	186,337	688,904
1952	546,774	189,627	736,401
1953	711,620	203,093	914,713

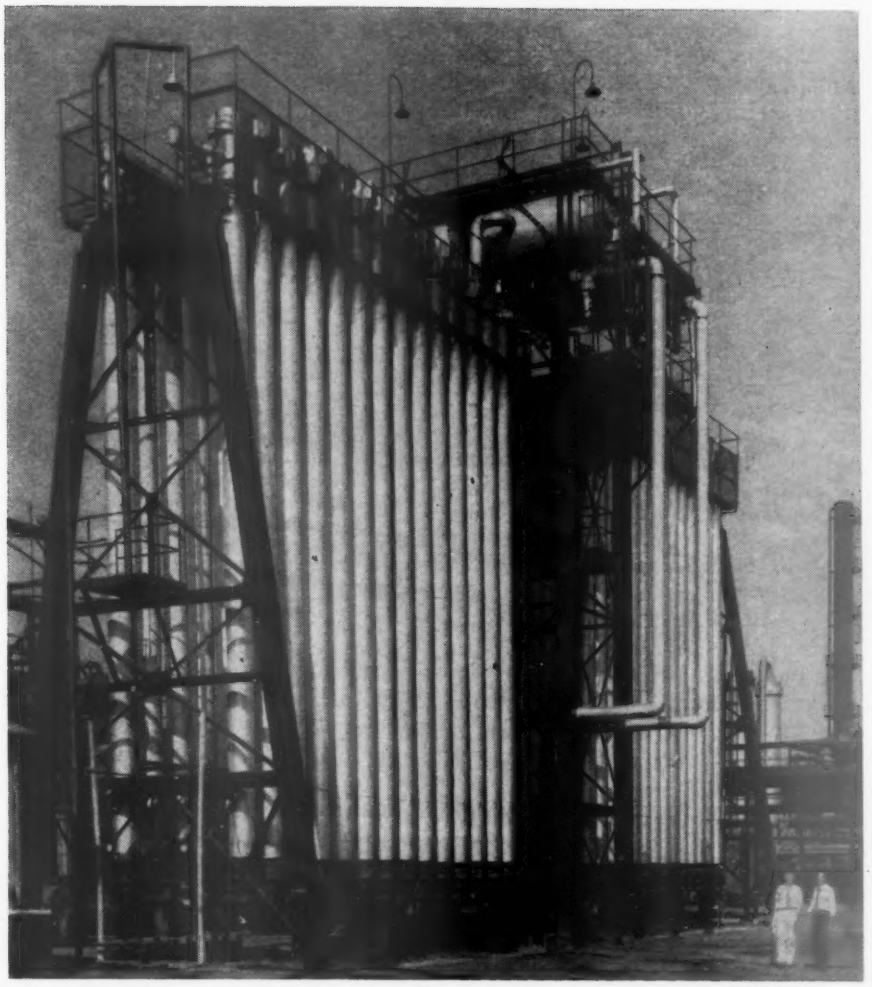


FIG. 1. Propylene tetramer, a basic raw material in syndet manufacture, is made in this "petroleum pipe organ" at Shell Oil's Wood River plant as a byproduct in making an additive for aviation gas.

Note that these figures in Table 1 are for the active agent, not for the built products, which for household use would be of the order of 3-5 times these quantities from different producers. A preliminary report of the Tariff Commission shows an increase of total syndet production for 1953 of about 25 per cent over 1952.

The large volume of production is of anionic, the alkyl aryl sulfonate type, principally the sodium salt of sulfonated dodecyl benzene. This type represents roughly 80 per cent of all syndets based on petroleum, the rest being non-ionics — to be discussed later. Manufacture of dodecyl benzene sulfonate products involves several steps: (1) production of alkylate, (2) sulfonation of alkylate, (3) neutralization of sulfonate, and (4) building and drying. (Fig. 1)

EXCLUSIVE

Alkyl Aryl Sulfonate

Alkylate Production. For several years the alkylate or hydrocarbon portion of the syndet was made by chlorination of a kerosine fraction boiling at 185-275 C, and reacting this with benzene by the Friedel-Kraft reaction to give an alkyl benzene in which the alkyl group was a mixture of different chain lengths, but with an average of C_{12}-C_{16}.

Better control of the chain lengths has been achieved by development of

propylene tetramer, which now largely replaces kerosine in U. S. manufacture. The latter is still used in Europe and by one U. S. manufacturer. Propylene is polymerized for another purpose under pressure in the presence of a catalyst such as boron fluoride, or of solid phosphoric acid. The desired dodecene is separated from the polymerizate by fractional distillation.

Alkylation of benzene by reaction with dodecene is carried out in the presence of a sulfuric-acid or by hydrofluoric-acid catalyst. The latter catalyst is used under pressure at about 40 C. With 90-100 per cent sulfuric acid, the temperature is kept at zero degrees. The acid phase may be recycled. The desired alkylate cut is separated by fractional distillation.

Production of alkyl benzene or "alkylate" is carried out by the petroleum companies, and to a limited extent by others. Some of these process the alkylate into syndets themselves. They also sell the alkylate to the large soap companies — the big three —to a few large chemical companies, and many smaller concerns. A considerable volume of alkylate is exported for processing abroad.

Sulfonation of Alkylate. Two methods are in use[1]; sulfonation with 20 per cent oleum, and with liquid sulfur trioxide. In the former method, which is used most, the alkylate is precooled to about 10 C in a No. 316 stainless steel, or in a glass-lined reactor. Addition of 20 per cent oleum is made slowly with agitation and cooling to prevent localized overheating. About 1.25-1.3 parts of oleum are required to 1 part of alkylate to give a monosulfonate. Addition of oleum is at such a rate that the temperature can be kept to 25-30 C. Agitation is continued about 2 hours after addition of the oleum, with the temperature still kept at about 25 deg. Only a minimal amount of unreacted alkylate may remain, usually under 2 per cent.

If a light-duty detergent containing 40 per cent or more of sodium sulfate after neutralization is required, spent acid is not necessarily separated. Such separation is desirable. For a heavy-duty detergent to be built with tripolyphosphate and other builders, maximum separation of spent acid is essential.

To accomplish this, water is added to the sulfonator with agitation, until the free sulfuric acid is 70-80 per cent. Ice may be added instead of water, in order to keep the temperature at 60-70 C. Temperature control is to avoid further darkening of the product, while at the same time promoting separation of sulfonic-acid from the aqueous sulfuric-acid layer in which it is insoluble.

The Authors

Cornelia Snell F. D. Snell

Cornelia Tyler Snell is research chemist and literature investigator for Foster D. Snell, Inc., and has had many years experience as a technical writer. In addition to being a Fellow of AAAS, she is a member of the American Chemical Society. She graduated from Syracuse University, received MA and PhD degrees from Columbia University.

Foster Dee Snell, head of Foster D. Snell, Inc., is an internationally known consultant and world chemical industry leader and has been or is active in practically every chemical and engineering organization in the western world. He holds a BS degree from Colleader. He holds a BS degree from Colgate University, an MA and PhD from Columbia University.

Mixture is pumped to a separating tank, where the sulfuric-acid layer is allowed to settle for 2-3 hours. A longer settling time tends to darken the upper sulfonic-acid layer. Spent sulfuric acid is drawn off, leaving the more viscous sulfonic acid containing 10-15 per cent of unreacted sulfuric acid.

Use of liquid sulfur trioxide is relatively new. Advantages are that excess of acid is not needed to complete the reaction, so that the final product contains little sodium sulfate. The difficulties of removing and disposing of spent acid are avoided. This results in a quicker process. Product is said to avoid the "kerosine" odor of those made by use of oleum. Liquid sulfur trioxide, is not easy to handle, however, and must be protected from contact with moisture to avoid polymerization to the explosive alpha form.[4] A high heat of reaction involves efficient heat removal.

The alkylate is advantageously pretreated with 10 per cent of 96 per cent sulfuric acid. Dry sulfur trioxide is vaporized, mixed with 9 parts of moisture-free compressed air, or of dry nitrogen, and added to the alkylate. The reaction mixture circulates in contact with an efficient heat exchanger. Sulfonation is at 50-60 C. Dilutent air is removed. About 0.36 lb of sulfur trioxide is required per pound of alkylate. Reaction time is kept to a minimum, which may be about 2 hours; neutralization follows immediately.

Neutralization. The viscous sulfonic acid is pumped to a stainless steel neutralizer equipped with an external heat exchanger. Commercial caustic soda solution — 50 or 70 per cent — is pumped to a measuring tank and from there run into the neutralizer, where it is diluted to 18-20 per cent. The sulfonic acid is allowed to flow slowly into the caustic solution with which it is mixed by agitation. The temperature should be kept down to 55-60 C. The last of the caustic solution is added in accordance with the amount indicated by titration of the still slightly acid mix, in order to give a neutral sulfonate. The final product contains about 50 per cent of water.

The amount of sodium sulfate is 10-15 per cent, with sulfonate by the oleum process, and practically nil with sulfonate made with sulfur trioxide.

Building. The slurry in the neutralizer is at 55-60 C after neutralization. Builders to give heavy-duty products are added directly to this; polyphosphates to increase detergent effectiveness, carboxymethylcellulose to improve dispersing power for solid soil and prevent greying of fabrics, fatty amide to stabilize the suds, silicate to reduce corrosiveness to metals, and a substantive fluorescent dye to improve the whiteness of washed linens. A typical formula is as follows:

Ingredients	per cent by weight
Dodecyl benzene sodium sulfonate	20
Sodium tripolyphosphate	45
Sodium silicate (1:3.25)	5
Sodium carboxymethylcellulose	0.5
Fatty amide	2.5
Sodium sulfate	22
Moisture	5
Fluorescent dye	trace

In a fair-sized plant, the slurry may be run into a second tank for addition of builders, so arranged that the 2 tanks could be used interchangeably for neutralization and building. Dry builders are added with heavy-duty, screw-type agitation in a steam-jacketed crutcher, to obtain maximum dispersion and solution. The temperature is kept at 55-60 C, with use of live steam if necessary. Air should not be beaten in as this would cause undesired foaming. Hot water is added to prevent the mix from becoming too viscous. If the product is to be drum-dried, the water content should be kept to 35-45 per cent; if spray-dried, it should be 50-60 per cent.

Drying. Drum drying is used for some industrial applications, where shipment over long distances is necessary and bulk density is important. The less expensive spray drier is suitable for household products, as it produces a lighter, dust-free bead. A drum-dried product may range from 40 to 45 lb

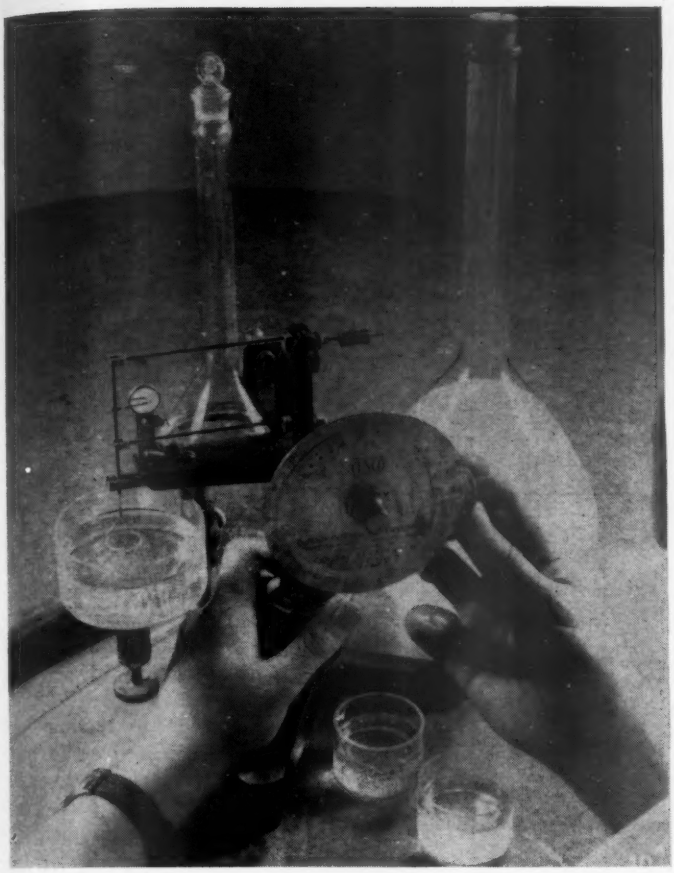


FIG. 2. The Du Nouy tensiometer is frequently used to screen syndets for their surface or interfacial tensions.

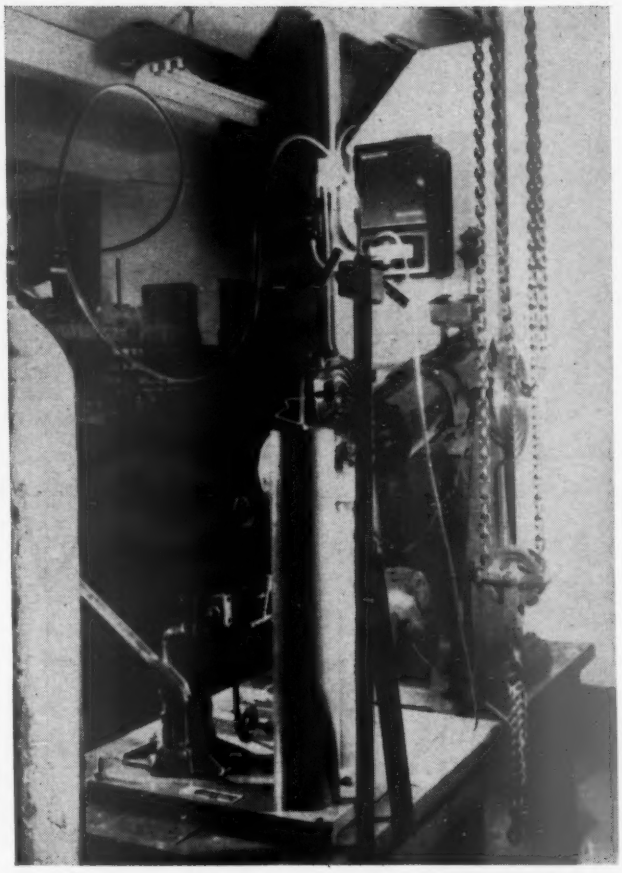


FIG. 3. Nonionics are manufactured in this Snell lab equipment by condensation with ethylene oxide.

per cu ft, spray-dried from 15-22 lb.

For *drum-drying,* slurry is pumped to a trough formed by 2 steam-heated drums of the dryer. As these rotate in opposite directions, each picks up a film of slurry which dries as it is carried around to the doctor-blades which scrape it off. The speed of rotation is such that when the doctor blades are reached, the moisture content will be 1.5-2 per cent. A difficulty is that tripolyphosphates may be overheated and revert in part to orthophosphate, an undesirable change.

With *spray-drying,* the built slurry is pumped at 82-99 C through atomizers into a stream of preheated air or gas. The fine spray, consisting of many small droplets, gives a quite uniform product. Some reversion of tripolyphosphate occurs, but can be more readily controlled. Danger of overheating is small if the entering gas temperature is at 400-480 C.

The dried particles are carried along by the gas stream to the product-collection system, where they are discharged to drums or to a screening and packaging unit. The loss of dry product as dust in the exhaust air can be kept below 1 per cent, and if necessary, eliminated by installation of a wet collector. As discharged, the particles are generally not over 65 C, after which they are air-cooled on a vibrating conveyor. If dried to 2-3 per cent moisture content, they do not cake in the container but remain free-flowing. Many products approach 10 per cent of retained moisture. A small particle size analysis from spray-drying gave 91 per cent of beads through 20 mesh and on 100 mesh. Material outside this range is mixed with incoming slurry.

Built heavy-duty alkyl aryl sulfonates, after spray-drying, having a bulk density of 15-20 lb per cu ft. Variations in bulk density can be made by adjustments in operating conditions. The larger the bead, the fluffier and lighter the product. Light-duty sulfonates tend to be of lower density than the heavy-duty type.

Nonionic Detergents

While these are of varied types, two typical reactions predominate. For the first type a long-chain alcohol or a substituted phenol is reacted. The preparation of this type is illustrative.[2] Dodecyl mercaptan is prepared by the reaction of hydrogen sulfide with triisobutylene. The mercaptan is then heated for two hours with sodium methylate at 100 deg under 10 mm pressure. Ethylene oxide is then added slowly over a period of 3 hours at 145-165 C, with a maximum pressure of 60 psi. The reaction product is stirred for 4 hours at 80 C, with about 4 per cent of acid-activated clay, followed by filtration. Resulting liquid solidifies partially at 18 C, and had the average formula:

$C_{12}H_{25}S\,(C_2H_4O)_{12}H$.

The second reaction is simpler and conducted on a relatively modest scale. One mole of fatty acid is reacted with excess of an alkanol amine such as 2 moles of diethanolamine. Then by heating at around 150 C the condensation occurs and water is distilled off. The reaction cannot be carried to completion. A typical end product is 65 per cent diethanolamide, 10 per cent diethanolamine soap, 25 per cent of free amine, diethanolpiperazene, and other substances. Minor amounts of water may total 5 per cent.[5] Other nonionics include polyhydric esters and ethers.

Popularity of Nonionics

Many of the nonionics are liquids exceeding 90 per cent of active agent. The liquid ethylene-oxide condensation products require the addition of more than a trace of water, otherwise around 90-100 F they separate into a hydrated and an anhydrous layer which, because of viscosity, do not readily mix to a homogenous liquid on cooling. They have had a limited popularity as dishwashing detergents. The

XUM

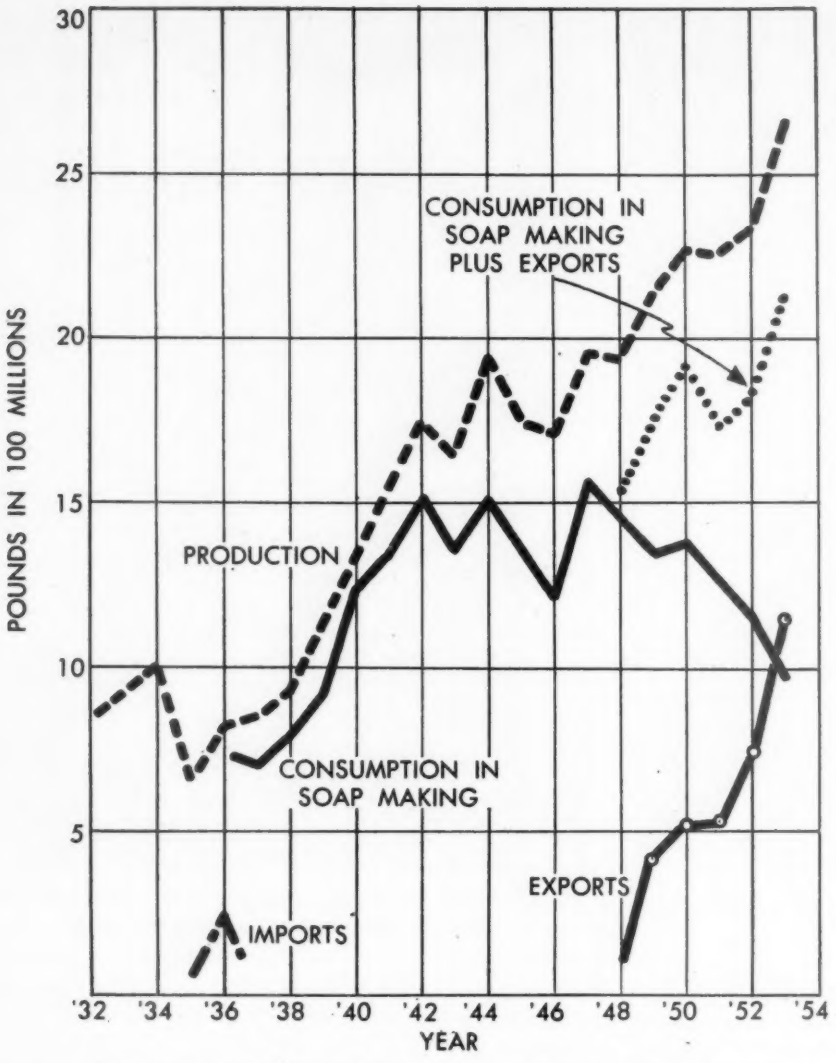


FIG. 4. Decreasing soap demand makes for an oversupply of inedible tallow up to nearly 2.7 billion lb in 1953.

better known products are solutions of anion-active agents, usually as the triethanolamine or ammonia salts. The current trend is toward increased sales of liquid syndets for industrial use.

Their cost is relatively high, necessarily so in comparison with heavily built solid products. For example, ethylene oxide sells for about 20 cents a pound in carload lots of drums, 14 cents a pound for tank carload lots. Propylene oxide is a little cheaper. Both have recently been reduced in price.

For some years the Monsanto Chemical Company has sold a dry nonionic surfactant made from tall oil and ethylene oxide. Recently they have gone extensively into the retail market with this as a low-sudsing product for use with automatic clothes-washers and dish-washers. Heavy suds slow down the mechanical action and washing efficiency of these machines.

Currently the three large soap companies — Procter and Gamble, Lever, and Colgate-Palmolive — are each test-marketing a low-sudsing detergent to compete with the Monsanto product. Two of these are built products much like other heavy-duty syndets in composition, except that part or all of the anionic detergent in the established commercial syndets is replaced by a nonionic. Instead of using a nonionic, one company is using a soap combined with an anionic syndet to give the low-sudsing property.[3]

Future Trends

As shown in Table 1, the trend has been toward increasing production of petroleum-based syndets at the expense of products based on other raw materials. Moreover, total syndet production has cut into soap sales so seriously that in 1953 for the first time syndet sales took 53 per cent of the total cleanser market. This trend is likely to continue as to the relative position of syndets and soap, although not in the pronounced fashion of the last few years.

Decreased soap demand resulted in an oversupply of inedible tallow, which not only brought the price of tallow down to 5-6 cents a pound, but stabilized it there. The lower price of tallow has brought the price of soap down, so that competition is keener on a price basis.

Fatty-alcohol sulfates, which hold a part of the syndet market, have until recently been made from imported and fairly costly coconut oil. Since inedible tallow has become readily available in large tonnage at a price not apt to fluctuate much, the same methods are applied for producing tallow alcohols, which are easily converted to syndets as tallow-alcohol sulfates. As these products compare favorably in detergent properties with the alkyl aryl sulfonates, they are a threat to the future growth of petroleum-based syndets.

Fig. 4 shows the increase in production of inedible tallow and its relation to the amount used in soap making. Production goes up, while soap-consumption goes down. Future displacement of soap by syndets will probably level off at a ceiling of 75 per cent syndet to 25 per cent soap.

Decrease in soap production correspondingly means less glycerine production from soap lye. Synthetic glycerine made from petroleum filled in the shortage. It is now produced at the rate of about 60,000,000 lb a year. Glycerine as a petrochemical means that there can never be real shortage of this except in war time.

Research on petroleum-based syndets may well result in new surfactants. On a pound-for-pound basis, sodium dodecyl benzene sulfonate made with propylene tetramer is not quite as effective a detergent as sodium lauryl sulfate made from coconut oil or sodium tallow alcohol sulfate. Builders have made the alkyl aryls very successful in competition with soap. Even better combinations of builders may be found than those used at present. In any event, the petroleum industry will be called on for large amounts of raw material of one composition or another. If the price of ethylene oxide can be further reduced by improved production methods, this can become an even larger-scale raw material in the syndet industry.

But the crystal ball says that 10 years hence the predominant products are apt to be those in the research laboratory today, or those just emerging into pilot-plant production.

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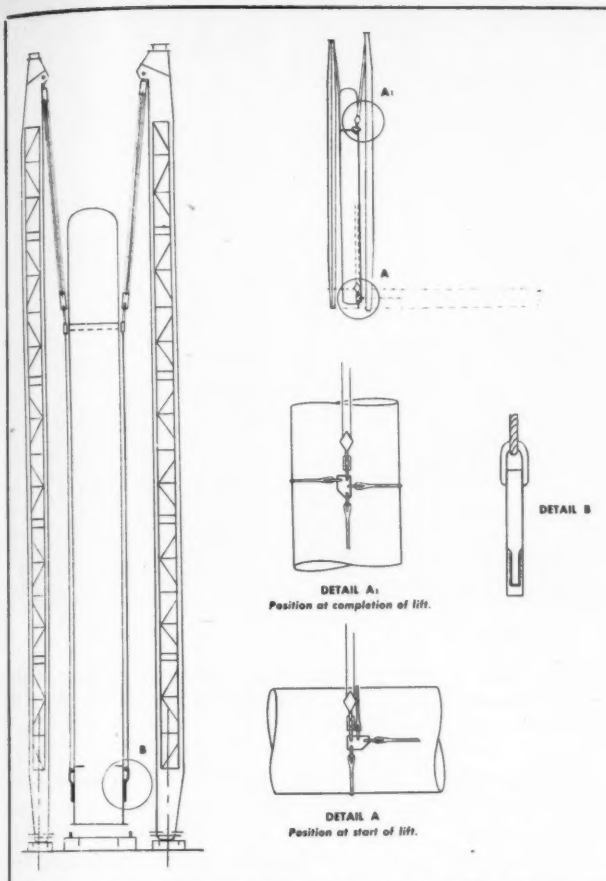

FIG. 1. Load adaptors, (Details A and A1), lifting stirrups (Detail B); for stress-relieved vessels under 100 tons.

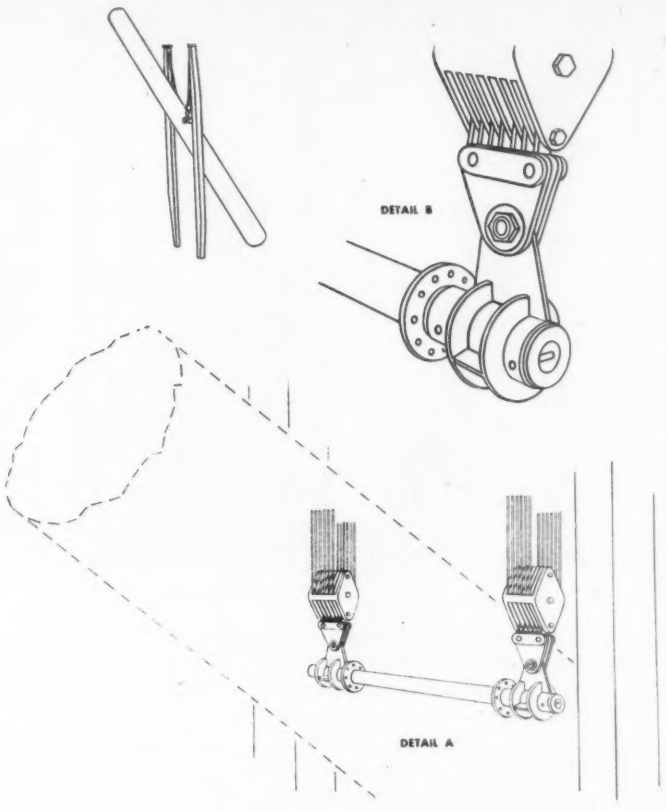

FIG. 2. Lifting bar (Detail A) and connections (Detail B), suitable for heavy lifts exceeding 150 tons, and extremely tall vessels.

RIGGING AND REFINERY CONSTRUCTION ECONOMICS

Careful analysis of all phases of problems needed to attain correct estimates of important factors

W. P. DOWNEY

OVER a period of many years, it has been noted that insufficient consideration is often given to the method of erection of major equipment during the design period of the work. It is believed that a general article calling attention to the various economies in time and money that can be effected by properly planning rigging operations would be well received.

One of the first considerations in any major refining construction program should be the method to be used in erecting the heavy equipment including vessels and columns. The method of erection may directly affect the design of the plant and all of the major equipment included. Proper consideration to such methods can materially affect the economies of construction in both time and money. In this article an attempt will be made to highlight some of the various equipment and methods used by the writer over the past 30 years.

Types of Equipment

Due to changing conditions, types of plants, and other considerations, it is considered that gin poles and large cranes are more adaptable for lowest cost in general refinery construction than other conventional methods such as use of stiff leg or guy derricks. Development of the use of the gin pole requires specialized consideration as to capacity and height.

Selection of gin poles will of course depend upon the availability of equipment. Assuming the erection of a vessel weighing less than 100 tons, approximately 6 ft in diameter by 100 ft high, it is believed that the most economical procedure would dictate the use of 2 gin poles with at least 50 tons capacity each and at least 85 ft in height.

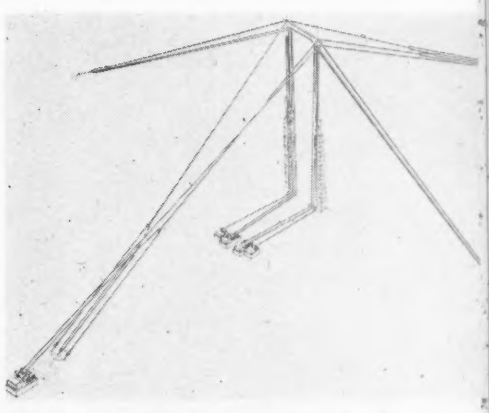

FIG. 3. Schematic diagram showing method for raising TCC units.

EXCLUSIVE

FIG. 4.

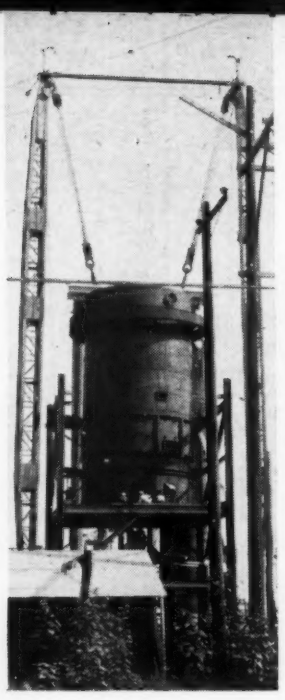

FIG. 5.

FIG. 6.

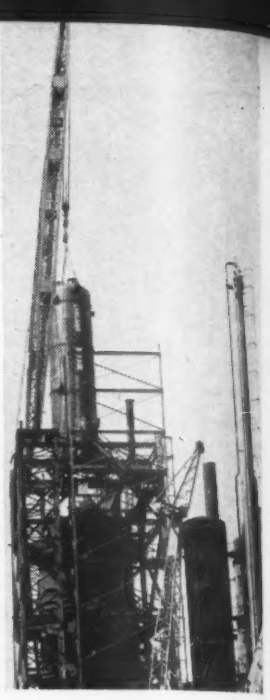

FIG. 7.

FIGS. 4-11. Steps in the erection of a TCC unit. FIG. 4. A 200-ft tower weighing 265 tons is lifted with two 150-ft, 150-ton gin poles. FIG. 5. Kiln is raised with base of gin poles on ground. FIG. 6. Raising a section of structural steel. FIG. 7. Base of gin pole has been elevated to 90 ft to lift 80-ton reactor for the TCC unit.

Fig. 1 indicates the type of hitch that has proven economical in use. This consists of 2 load adapter plates that are attached to the side of the vessel at a preselected height above the center of gravity and connected by suitable chokers to stirrups that are welded to the skirt of the vessel. This arrangement for erecting the vessel has the advantage of being of low cost installation as well as obviating any necessity for welding or heating the vessel proper. This is especially adaptable to stress relieved vessels or columns as the stirrups are welded directly to the skirt and may either be left in place for use in lowering the vessel at some later date or cut off as soon as the vessel is erected. The maximum weight lifted by this type of connection is limited to approximately 100 tons due to the necessity for securing suitable load shackles in converting the load direction.

In the event of a vessel weighing from 150 to 300 tons with a height in excess of 150 ft, the most economical method of erection has been by the use of a lifting bar with 150 tons capacity at 125 to 150 ft gin poles. Fig. 2 shows the details of a lifting bar that has been utilized in many lifts during the past several years. The bar is suitable for a maximum load of 300 tons and for varying diameter of vessels. Fig. 4 shows arrangement utilized in erecting a vessel 265 tons by 200 ft high by the use of two 150 ton capacity poles and the lift bar referred to above.

Ingress and Egress

In planning the rigging operations,

FIG. 8. Section of structural steel raised and threaded over top of reactor and towers. FIG. 9. Raising hot "Cat" storage bin. Base of gin poles are now at height of 150 ft. FIG. 10. Erecting last section of structural steel and placing it over the "Cat" bin. FIG. 11. Raising separator surge to top of structure. Elevation to top of gin poles is 278 ft.

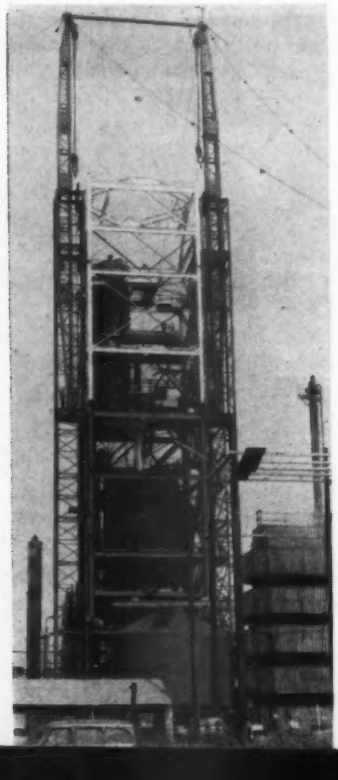

FIG. 8.

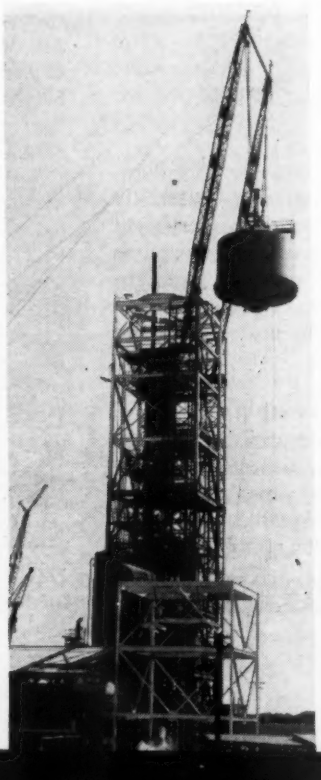

FIG. 9.

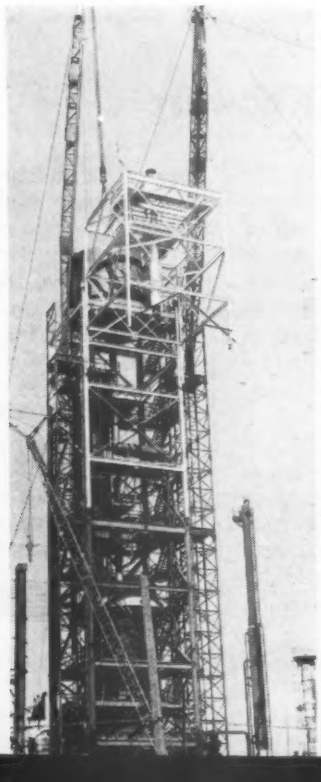

FIG. 10.

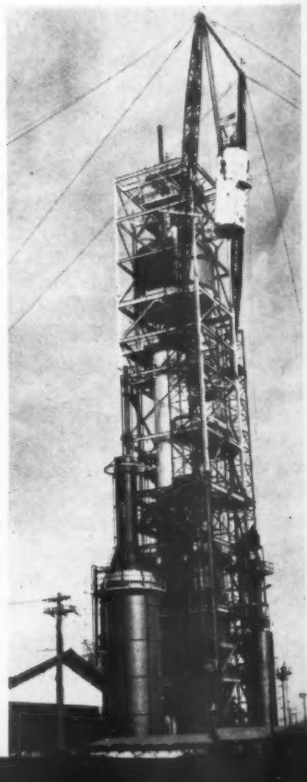

FIG. 11.

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The Author

W. P. Downey is manager of construction and vice president of the construction division of The Fluor Corporation, Ltd. Downey began in construction work as a timekeeper in 1918. He later became an ironworker rigger in 1925 and worked for Braden Steel Corporation and Kansas City Structural Steel Company. In 1930 Downey joined Fluor as an ironworker foreman and rigging superintendent of the construction division before he received his present position.

it is essential that proper provision be made for bringing the vessel into position for raising over the foundation. Planning of this particular phase of the work offers a great deal of potential savings in both time and money as anything that can be done to allow progress of the work throughout the area with the least amount of delays due to roadways for equipment erection will expedite completion and contribute to the economies of construction.

Erection Method

Erection of structure and vessels or columns such as a TCC unit posed a problem of economy and speed of construction. Fig. 3 schematically shows the arrangement utilized in the erection of a number of TCC units. In developing this method of erection, it was necessary to give consideration to design of the structure and each vessel to be installed therein and to develop rigging equipment that could be suitably adapted for carrying on the various operations necessary. It was necessary to agree upon the height of the initial structure to be installed from ground level and arrange the support towers for connection at proper points on the main structure to allow transfer of load to the main structure.

Erection Equipment

The most economical arrangement for the use of the available equipment indicated support towers having a maximum of 150 ft. It was necessary to provide gin poles 125 ft in height with a capacity of 130 tons and arrange for method of utilization of the gin poles at their original height of 125 ft with provision for jumping the poles to provide a height of 215 ft and as the work progressed again jump the poles to the maximum height of 275 ft to top of pole.

The gin poles were utilized in their original position on either side of the main structure to lift the kiln into position. The poles were then utilized to lift the steel structure that was threaded over the kiln into position. Figs. 4, 5, 6, 7, 8, 9, 10, and 11 indicate the various steps in the erection of the major parts of the TCC unit.

In order to proceed in the manner illustrated, it was necessary to provide main load hoists, booming hoists, pole jumping hoists, and live guy hoists with arrangements for power for whip or runner lines. The power for main load lifts was provided by the use of 2 single drum torque convertor hoists with a spooling capacity of 5000 ft of ⅞-in. cable and a straight line pull of approximately 50,000 lb. The booming hoist used was a 2-drum gas-driven hoist with 12,000 lb straight line pull and a spooling capacity of 2500 ft of ⅝-in. cable per drum. In order to properly control the booming operation, luffing lines were used on the fore and aft guys as indicated in Fig. 3.

Erection Procedures

Each piece of rigging equipment utilized in these operations was selected for adaptability to the needs. The various units to be erected had to be designed to enable moving them along the ground and raise into position without the danger of collapse or rupture.

A special device was developed to jump the poles through the support towers utilizing two 6-sheave 50-ton load blocks with ¾-in. load line.

A special hitch was designed and utilized for the erection of the kiln. The same lifting bar arrangement developed for the kiln was removed after landing this equipment and re-used with but slight alteration during the erection of the hot cat storage bin. Fig. 12 illustrates details of lifting bar utilized in erection of the kiln and hot cat storage bin.

Erection of the reactor, which weighed approximately 80 tons, was handled by use of lifting lugs attached to the upper seam of the vessel. Fig. 13 illustrates the design of the lifting lugs and the method of connection for erection of this vessel. Erection of the separator surge requires special consideration due to the elevation of the vessel in its final position and the danger of two-blocking during erection. Fig. 14 indicates lifting wings that were designed and installed on the separator surge to provide connecting point that

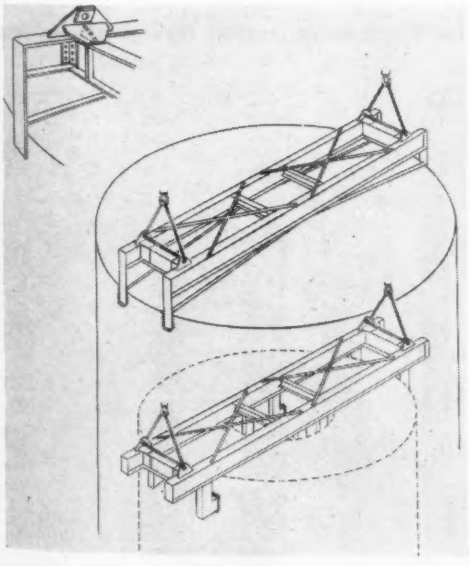

FIG. 12.

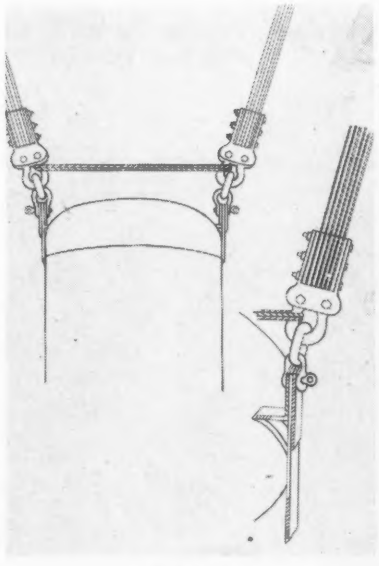

FIG.13.

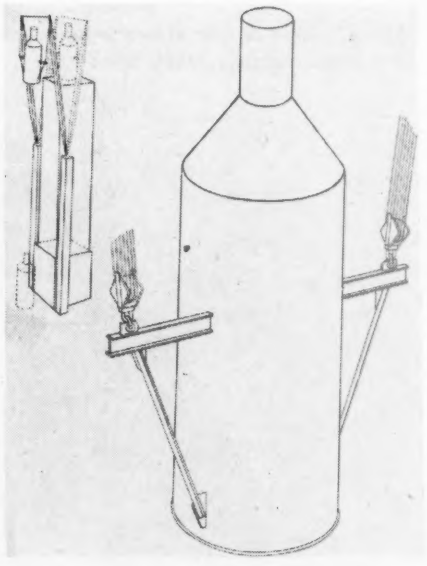

FIG. 14.

FIG. 12. Special lift beam, for lifting both kiln and hot bin. FIG. 13. Lifting lugs or ears, for vessels when rigging equipment allows hooking to vessel top. FIG. 14. Lift wings for separator surge tank, where rigging equipment height is limited.

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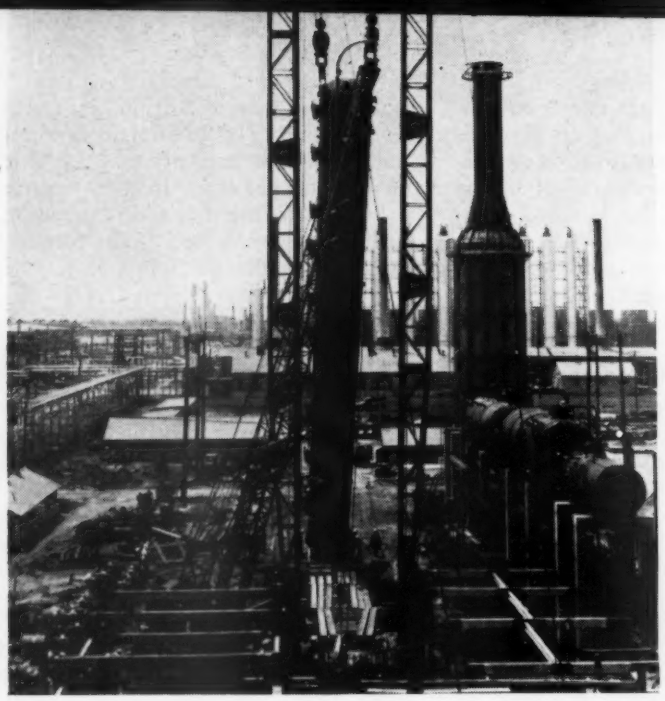


FIG. 15. Erection of first of four vessels, 90 tons, 8-ft, inside diameter, 105-ft height.

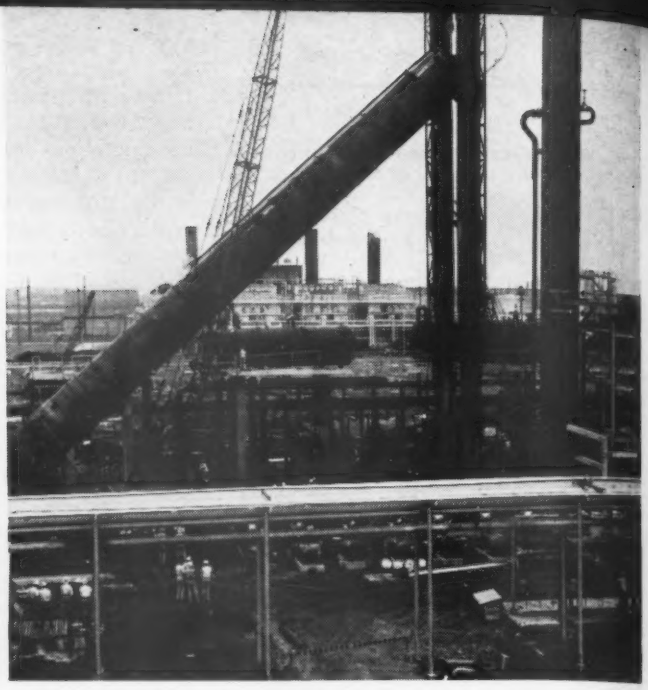


FIG. 16. Erection of second of four vessels — 175 tons, 9-ft inside diameter, 120-ft height.

would maintain the load in a vertical position during erection.

Unit Construction Planning

In utilizing this type of erection for the TCC unit, it was necessary to plan the other phases of construction to allow fabrication of the kiln and the hot cat storage bin in the area of the TCC structure and to also erect sections of the steel work on the ground ready for moving into position for lifting into place. All possible operations were carried on simultaneously on the ground in as efficient a manner as possible to obviate interference with other phases of the construction necessary in the vicinity of the main TCC structure. Plans are necessary much in advance of requirements to effect the most economical procedure with the least interference with other operations. Erection of the TCC unit above referred to gives an example of planning rigging operations along with structure and equipment design to contribute to efficiency of operation and best utilization of time and money.

Erection of the TCC unit in the manner outlined above resulted in a savings of approximately two months determined amount in direct labor costs.

Use of Large Gin Poles

On a recent job, it was necessary to erect 4 vessels ranging from 90-in. ID by 90 ft with 113 tons to 108-in. ID by 120 ft high at 175 tons. Prior to finalization of plant design, consideration was given to method of erection of the 4 main columns.

Erection of the vessels was accomplished by use of 2 gin poles 150 ft in height attached to the load by means of lifting lugs welded to the top of each vessel. It was also necessary to give proper consideration to the spacing of the foundations for these 4 vessels and the method to be used in skidding the poles from one to the other for erection of each vessel in turn. Proper scheduling of the vessels was of prime importance after sequence of operation and

FIG. 17. Third of four vessels being erected; 208 tons, 11-ft inside diameter, height 108-ft.

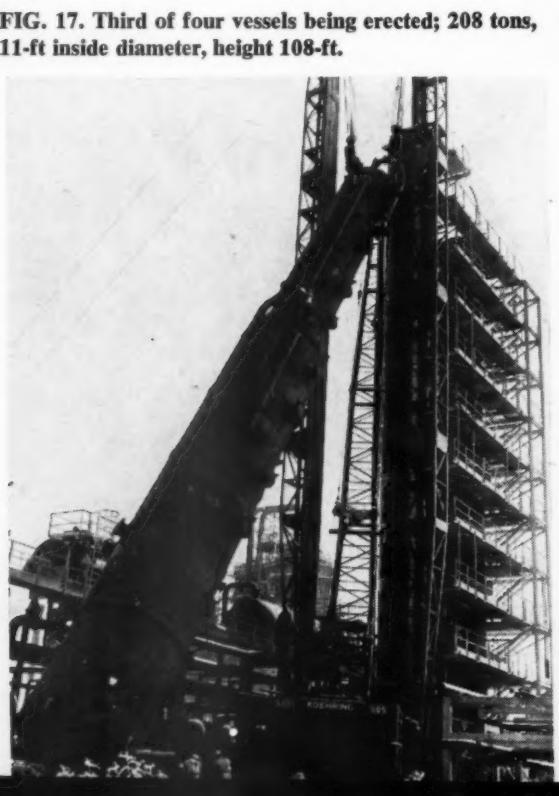


FIG. 18. The last of four tall vessels being erected; 7½-ft inside diameter, 90-ft high, 113 tons.

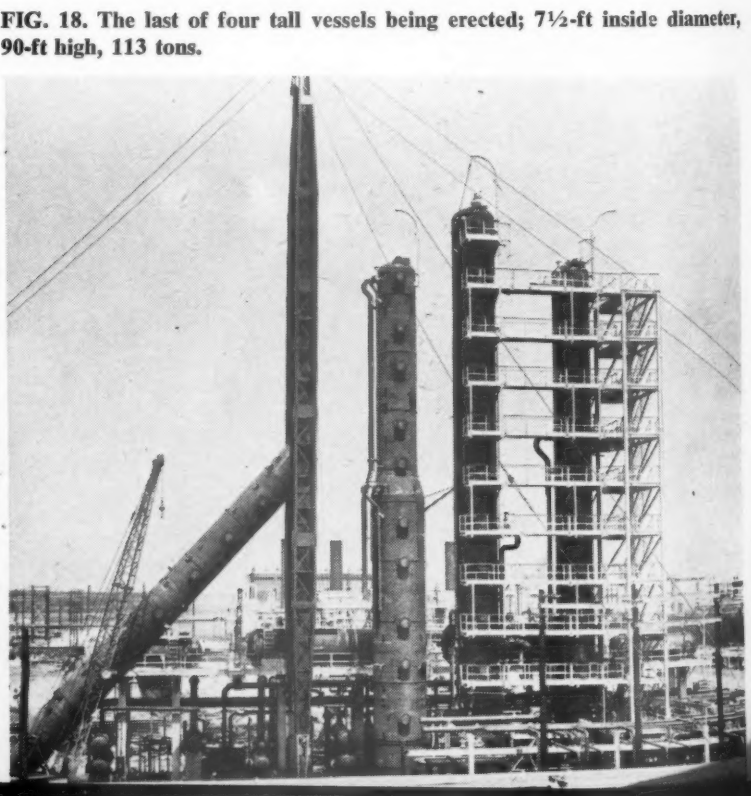


FIG. 19. View of construction area, with concrete structures for three vessels, completed, ready for vessel installation.

final method of procedure had been decided upon.

Of prime importance in the erection of the 4 vessels referred to above was the erection and removal of the gin poles after the vessels had been placed on their foundations. The gin poles required for the loads to be erected weighed approximately 40 tons each, and a review of available equipment indicated that the large crane on the job did not have sufficient capacity to erect and remove these poles.

After weighing the economies of all possible methods of procedure, it was finally decided to erect the large poles by the use of two smaller poles and remove them in the same manner upon completion of the erection of the four vessels. In making this decision, it was necessary to survey the availability of larger rigs in the area, weigh the cost of transportation in and out as against the cost of transporting smaller poles to and from the job, and cost of utilization of small poles for this service. A suitable equalization bar was developed and constructed for use in raising and lowering the poles with the two smaller gin poles. This, in the final analysis, was considered the most economical procedure under the conditions.

It will be noted from Figs. 15, 16, 17, and 18 that erection of the 4 vessels proceeded without delaying the installation of pipe work, pumps, etc., in the immediate vicinity of the foundations. By proper design and planning of these operations, no delay was necessary in completing the auxiliary piping on either side of the main columns. It is estimated that this procedure effected a savings in elapsed time of construction of approximately 4 to 6 weeks with a consequent economy in money.

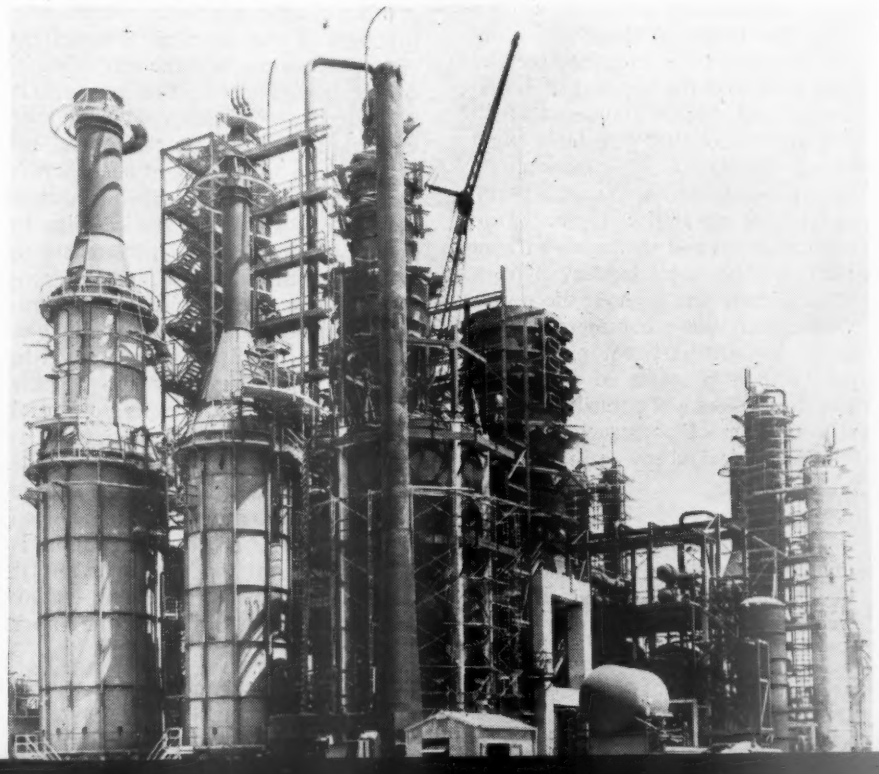
Use of Cranes

In the design of additions to refinery and gasoline plants, equipment and other items to be installed have required the use of large cranes of a capacity in excess of 50 tons. On a recent job it was possible to utilize large cranes that were available in the area of the work and save considerable time of construction and a great deal of expense that might have been incurred in erecting with other types of rigging equipment.

The vessel to be installed consisted, among other vessels and columns, of 3 columns to be installed on concrete foundations. These vessels were erected on structures approximately 42 ft above ground elevation. A complete survey of available equipment indicated the advisability of utilization of large cranes for erection of these vessels. By planning the operations and designing the vessels, we were able to erect each vessel in sections and utilize the large rigs on other phases of the work to good advantage while welding of the vessel section was proceeding. Figs. 19 and 20 illustrate the magnitude of the construction and utilization of the cranes in field erection and fabrication of the large vessels.

The top section of the largest vessel required raising of one section weighing

FIG. 20. Completed installation of three main vessels, methods used permitted installation of other facilities on all sides of these vessels.



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19½ tons to a height of 150 ft. This was accomplished by using 2 large capacity cranes with 175 ft of booms in each.

All sections of each vessel were lifted by means of these cranes and work progressed on all other phases of the plant simultaneously. Utilization of this type erection equipment required considerable planning of all phases of the operations, but results experienced fully justified the decision.

Major Items to be Considered

The above examples and methods of procedure illustrate the advisability of giving consideration of methods of erection of all major equipment prior to finalization of design of the plant. In summarizing the above comments, it is recommended that consideration be given to:

- **(a) adaptability of readily available rigging equipment**
- **(b) most economical method of rigging procedure**
- **(c) efficient deadmen and rigging layout**
- **(d) revision of plant design to effect economies in time and money in adopting rigging procedures**
- **(e) method of removing rigging equipment, including dismantling and hauling from site.**

Conclusion

It is recognized that there are many other examples of types of rigging procedures but it is felt that these will serve to illustrate the necessity and advisability of planning rigging procedures along with design of the plant.

It is the writer's considered opinion that in the erection of all major refinery additions, many economies can be effected if consideration is given to the manner in which equipment, large vessels and columns are to be erected during the design of the plant. Consideration must be given to the method of erection, and the method of hook-on to the load, and the manner in which the vessel or structure is to be brought into its foundation for erection. By proper planning and layout of a plant, it is felt that erection can proceed on the main vessels and structures without increasing either capital outlay or plant operating costs and without the necessity of leaving out a considerable portion of the auxiliary equipment and piping during progress of the work. All of these items will contribute to the saving of time of construction which will effect a marked saving in costs.

* * *

The petroleum industry uses 2800 operations to supply petroleum for aircraft in its complex and varied America's needs.

Du Pont Fall, 1954 Gasoline Octane Number Survey

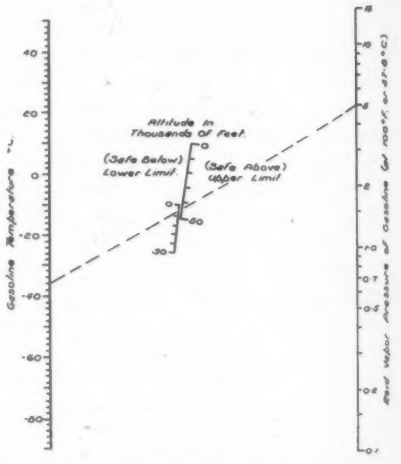
City	Premium Octane No. Motor	Premium Octane No. Res.	Premium TEL cc/gal	Regular Octane No. Motor	Regular Octane No. Res.	Regular TEL cc/gal
Aberdeen, South Dakota	83.4	91.2	2.38	80.3	84.1	2.13
Amarillo, Texas	83.5	91.5	2.08	79.9	83.6	2.49
Atlanta, Georgia	84.6	94.6	2.34	81.2	86.5	2.28
Barkersfield, California	85.0	92.2	2.90	78.5	83.9	2.00
Baltimore, Maryland	84.8	94.6	2.64	82.7	89.2	2.32
Boston, Massachusetts	84.2	94.8	2.25	83.0	89.8	2.28
Calgary, Atlanta	80.1	88.7	2.76	78.8	82.9	2.13
Casper, Wyoming	81.0	90.2	1.55	77.8	83.1	1.30
Charlotte, North Carolina	84.4	94.5	2.31	81.3	86.6	2.39
Chicago, Illinois	84.0	92.2	2.20	80.4	85.0	2.05
Cincinnati, Ohio	84.2	93.4	2.59	81.7	87.5	2.38
Cleveland, Ohio	84.8	93.7	2.24	81.8	88.9	1.96
Columbus, Ohio	84.3	93.6	2.57	81.7	88.4	1.88
Corpus Christi, Texas	86.8	93.9	2.73	82.6	85.9	2.27
Dallas-Ft. Worth, Texas	85.5	95.3	2.48	80.3	86.3	2.12
Denver, Colorado	83.1	90.4	1.93	79.0	83.1	1.50
Detroit, Michigan	84.8	93.7	2.23	81.7	88.0	1.81
Edmonton, Alberta	81.7	89.4	1.86	78.7	83.5	1.40
El Paso, Texas	85.2	92.8	2.89	78.3	82.6	2.60
Great Falls-Billings, Montana	81.5	92.6	2.13	78.2	84.7	1.94
Houston, Texas	85.7	94.9	2.53	81.5	86.8	2.28
Indianapolis, Illinois	84.9	93.5	2.35	79.9	84.6	1.97
Jacksonville, Florida	84.2	94.9	2.06	82.6	89.0	2.32
Kansas City, Missouri	84.0	92.1	1.88	80.6	84.6	1.85
Little Rock, Arkansas	85.4	95.3	2.71	81.1	86.4	2.55
Los Angeles, California	83.3	93.3	2.66	78.2	84.4	2.00
Louisville, Kentucky	85.2	94.2	2.77	81.6	86.4	2.55
Memphis, Tennessee	85.2	94.7	2.38	82.2	86.6	2.17
Milwaukee, Wisconsin	84.7	93.6	2.33	79.7	84.6	2.01
Minneapolis, Minnesota	84.2	92.2	2.42	80.5	84.7	2.20
Montreal, Quebec	82.6	92.1	1.74	81.0	87.7	1.67
Nashville, Tenneesee	84.6	94.4	2.65	81.5	86.7	2.41
New Orleans, Louisiana	85.5	94.3	2.66	81.7	87.0	2.29
Metro, New York	84.8	94.5	2.49	82.6	89.3	2.21
Omaha, Nebraska	84.5	91.7	2.30	81.0	84.4	2.17
Philadelphia, Pennsylvania	84.4	94.7	2.25	82.3	90.3	2.30
Pittsburgh, Pennsylvania	84.2	94.6	2.32	83.0	89.8	2.44
St. Louis, Missouri	85.1	92.3	2.52	80.6	84.7	2.26
Salt Lake City, Utah	82.3	89.8	1.49	78.1	81.8	1.65
San Francisco, California	83.5	93.7	2.63	78.6	85.1	2.10
Seattle, Washington	83.4	93.5	2.67	79.7	84.9	2.27
Shreveport, Louisiana	85.7	94.9	2.45	81.3	86.1	2.46
Spokane, Washington	83.0	92.8	2.24	79.3	85.1	1.78
Toronto, Ontario	82.4	92.6	2.03	81.0	87.8	1.31
Tulsa, Oklahoma	85.4	92.0	2.34	80.8	84.7	1.94
Vancouver, British Columbia	83.0	91.6	2.00	80.5	84.0	1.78
Wichita, Kansas	84.6	91.6	2.22	80.6	84.0	1.70
Winnipeg, Manitoba	81.8	92.3	1.14	79.2	85.2	1.25

PLANT AIDS

Limits of Inflammability of Aviation Gasoline

George E. Mapstone

As the amount of gasoline vapor in air is increased, the mixture is successively non-explosive, explosive, and then again non-explosive. The factors influencing the explosive limits are the gasoline vapor pressure, which is a function of the gasoline temperature and composition, and the air pressure, which is related to the barometric pressure. Another factor which can be important, but which cannot be allowed for to any degree of accuracy, is is the approach to equilibrium conditions in the air above the gasoline in the tank under practical circumstances. Because of this situation, it is customary to assume equilibrium conditions. The accompanying nomograph enables the explosive limit to be estimated in terms of altitude simply and quickly from the gasoline temperature and Reid vapor pressure (determined at 100 F).


Altitude in Thousands Of Feet
(Safe Below) Lower Limit
(Safe Above) Upper Limit
Gasoline Temperature °F
Reid Vapor Pressure of Gasoline @ 100°F (37.8°C)

Rvp of gasoline (at 100 F or 37.8 C).

Example: The temperature of the gasoline in the tank has been reduced to —36 C. The rvp of the gasoline is 5 lb. What are the explosive limits? Connect —36 deg on the temperature (left hand) scale to 5 lb on the vapor pressure (right hand) scale. The line cuts the lower limit scale at 5000 ft and the upper limit scale at 44,000 ft. The air in the tank will be explosive between these altitudes.

Note: This chart is accurate to within 1 C of the limits obtained from the chart FD/6 issued by the Royal Aeronautical Society, London.

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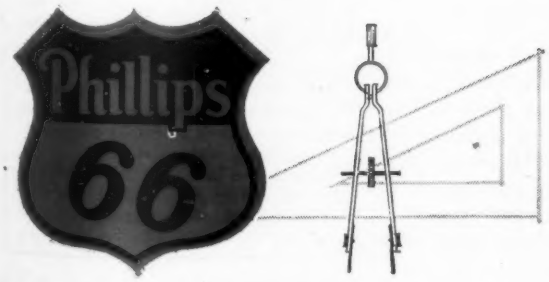

INSTRUMENTS SALES DIVISION

PHILLIPS PETROLEUM COMPANY

Bartlesville, Oklahoma

Four-coat paint system . . .

To Combat Atmospheric Corrosion†

. . . shows good results on tanks

F. T. RADECKE*

THE need for improved paints and application control was disclosed during an investigation in 1947 and 1948 of painting practices in Shell Oil Company's refineries. In many cases it was found that expensive materials of poor quality were being used, and good application practices were lacking. The history of painting was principally one of short coating life and high unit cost. Needless to say, the protection afforded against atmospheric corrosion was not satisfactory.

An organized effort was initiated by the Shell Oil Company in 1948 to reduce atmospheric-corrosion costs and to improve exterior coating durability. The project was outlined in four phases: Program, organization, material, and application.

This article covers the details of the 4 stages. In the conclusion the cost data are evaluated to indicate savings in excess of 55 per cent in application costs and more favorable results for unit cost per year of coating life.

Program

This phase was covered by the issuance of a booklet, entitled *Protective Coating Manual,* to all manufacturing units in the company. The text, prepared by Shell Oil Company's engineers with the assistance of prominent paint-industry authorities and federal agencies, provided a method of approach to the problem of protective-coating improvement. The manual is used for the guidance of technical and craft personnel in all steps of surface preparation and paint application. Paint technology continues to advance, and new ideas frequently are conceived in the field. Therefore, it is necessary to revise the manual from time to time in order to keep pace with the developments.

The contents of the manual apply principally to tanks, as they are the major exterior surfaces that require protection in the plants.

*Shell Oil Company, Wood River, Illinois.

†Presented during the 19th Mid-Year meeting of the American Petroleum Institute's Division of Refining, Houston, Texas, May 10, 1954.

Piping, equipment, and structures, however, are to be considered applicable items under the provisions of the manual. The contents include general color standards, surface preparation, paint systems, coated-panel and material test procedures, standard-service coating-record outlines, and paint formulas. The text outlined procedures for both new and repainted surfaces in the foregoing detail. Table 4 shows the standard tank painting record as outlined in the booklet. This two-page form is used for individual tanks.

As a further guide to engineering and craft personnel a *Manual of Painting Practice* was issued in 1951. Prepared in much the same manner as the original *Protective Coating Manual,* this publication is intended as a supplement to increase knowledge of protective-coating materials. The text contains sections on pigments, vehicles, film thickness, various types of coating materials, corrosion, causes of paint failures, paint testing and manufacture, and additional data on surface preparation and material application.

Organization

An organization known as the Atmospheric Corrosion Subcommittee was created as part of Shell Oil Company's management engineering council, which correlates engineering problems within the company. There is a subcommittee chairman who conducts an annual meeting of the subcommittee, which is composed of an engineer from each refinery assigned to atmospheric-corrosion mitigation.

These so-called "paint engineers" are responsible for supervision and interpretation of the manual, development of paint systems in special cases of severe environments, initiation of test work, and requisitioning of material requirements. The paint engineer works closely with paint-craft supervisors on all phases of coating activities. The chairman annually visits all the plants for field observation and discussion of coating problems. He also advises subcommittee members and management of progress and development.

To work with the paint-craft supervisors is the most important function of the engineer. Inasmuch as the supervisors are of the old school that takes pride in high spreading rates per gallon, considerable time must be expended to sell the newly-developed concepts of film thickness and uniformly applied coatings. The supervisor is expected to train the craftsmen in accordance with these new ideas.

In addition, inspection of applied coatings was inaugurated in all plants. Craftsmen who exhibited superior intelligence and spray-painting capabilities were selected as full-time inspectors in the larger plants. This practice also provides supervisory training for future needs. Inspection of Shell Oil Company's and contractors' work includes approval of surface preparation and coatings in a given paint system. The inspector makes visual examination and measurement of the dry films and is responsible for maintenance of the coating records.

In the course of the work to improve protective coatings it was found

The Author

Frank Radecke is a 42-year-old veteran of petroleum engineering whose last 21 years have been spent with the Shell Oil Company. A senior engineer at the company's Wood River refinery since 1943, he was assigned recently to the New York head office to head engineering standards development. He is also chairman of the manufacturing department's atmospheric corrosion committee which is primarily concerned with corrosion mitigation.

Radecke is a former student at Washington University of St. Louis and the Illinois Institute of Technology.

that the professional house painter usually is a poor industrial painter. Spray painting of tanks and structures is a relatively new application method, which is somewhat faster than brush painting and tends to coat the painter as well as the steel surfaces. These craftsmen are difficult to instruct and are seldom satisfied to remain employed as spray painters. Accordingly, applicants for the paint craft have been given intelligence tests, among others, to assist supervisors in selection of personnel. Men with the better intelligence-test results prove to be more adept in learning industrial painting procedures, and they remain employed as satisfactory craftsmen.

Materials

Observations in the field disclosed many early paint failures after one to three years of film life. Corrosion was not always evident through the primers. This indicated external causes such as inadequate thickness of the applied coatings or poor weathering capacity of the dry film. Proprietary primers and finished coatings were purchased from a number of paint manufacturers, mostly on the bases of application ease and finish appearance.

Because of the multiplicity of corrosion-resistant paints on the market—many untried and backed by extravagant claims—it was difficult to make selections by other than trial-and-error experience. Inasmuch as this method had yielded little gain in the past, specifications were prepared for paint formulas. Public agencies, such as the army engineers and experts in the basic paint-materials field, were consulted when the formulas were written. This enabled Shell to take advantage of research and development work that had been previously concluded by others, and to quickly start a program with proven coatings.

Most of the currently used paint specifications are based on the alkyd- and phenolic-resin vehicles in white, aluminum, gray, and black finish coatings. The Shell Development Company presently is working on specification formulas in epoxy- and vinyl-resin vehicles for general plant application in an effort to extend durability and to improve appearance. The long-range appearance factor is becoming increasingly important as coating durability increases and the repainting cycle is reduced.

In the development of primers one of the most significant decisions that had been made was to employ only inhibitive-type pigments, because the inert pigments, such as iron-oxide and siliceous extenders, demonstrated poor durability in plant environments. Our experience was that the inert primers required renewal as frequently as the finish coatings weathered away. There are three commonly used specification primers, all pigmented with red lead as the inhibitive agent. The primers, designated as "A," "B," and "C," are as indicated in Tables 1, 2, and 3.

The primer designated "A" was adoped because of its fine surface-wetting characteristic. It is commonly sprayed on bare sandblasted steel because it will flow freely into weld seams and plate irregularities. Good spraying properties plus the high surface-wetting characteristic have eliminated paint-brush applications in all work in which the steel has been cleaned by sandblasting.

Primer "B" sprays well and has excellent durability. It is hard and resistant to weathering when finish top coats wear away or are mechanically pierced.

TABLE 1. "A" Shell Standard 19-1.11.

Meets federal specification TT-P-86a, Type 2
Red-lead mixed-pigment alkyd-varnish linseed-oil paint composition

	Per cent by weight	
	Minimum	Maximum
Pigment:		
Red-lead 97 per cent grade	65.0	....
Red iron oxide	15.0	17.0
Magnesium silicate	....	14.7
Mica (325-mesh)	4.0	6.0
Aluminum stearate	....	0.3
Vehicle:		
Raw or alkali-refined linseed oil	28.0	....
Alkyd-resin solids	28.0	....
Volatile mineral spirits and drier	....	44.0

TABLE 2. "B" Shell standard 19-1.12.

Meets federal specification TT-P-86a, type 4
Red-lead mixed-pigment phenolic-varnish paint composition

	Per cent by weight	
	Minimum	Maximum
Pigment:		
Red-lead 97-per cent grade	85.0	....
Diatomaceous silica	....	8.0
Magnesium silicate	....	6.6
Aluminum stearate	0.3	0.4
Vehicle:		
Phenolic varnish	44.0	....
Mineral spirits, solvents and drier	....	56.0

TABLE 3. "C" Shell Standard 19-1.13.

Meets federal specification TT-P-86a, type 1
Red-lead linseed-oil paint composition

	Per cent by weight	
	Minimum	Maximum
Pigment:		
Red-lead 97-per cent grade	99.6	....
Aluminum stearate	0.3	0.4
Vehicle:		
Raw linseed oil	35.0	50.0
Pale heat-bodied linseed oil	15.0	30.0
Volatile mineral spirits and drier	....	35.0

Primer "C" was adapted for brush applications on bare hand-cleaned, repainted surfaces. As a large portion of plant painting is on hand-cleaned surfaces—especially in operating areas—spraying of primers is not practical on a spot basis, nor can spraying be done freely in all cases. In other words, this is a first-coat spot primer.

Each of the primers has a definite function and is used accordingly. Finish coats applied over the primers are selected in accordance with plant color schemes. However, the finishes are high in resin-solid content in the varnishes, and are pigmented with materials least reactive to an industrial environment, such as titanium in white and grays. The commonly applied aluminum coatings are in this category.

There are also specifications prepared for vinyl and water-soluble-type wash primers. It is intended that these materials will be used in addition to, and under, the primers previously outlined herein. They are expected to provide added surface protection in the more severe environments and on tank roofs. There are approximately 2,000,000 sq ft of surface in the refineries coated with wash primers. It will be some time before their worth can be evaluated.

Specification paints are being purchased for approximately the same price as the unsatisfactory proprietary products formerly applied—all at less than $5 per gallon. Finish and primer materials are carried in warehouse stock in the individual plants, and stock replenishment is made on the paint engineer's predictions of need to the purchasing and stores department. The purchasing department submits the specifications to the manufacturers who quote their price for the material being ordered. The paints are being made by a large number of manufacturers from coast to coast with good uniformity. On delivery, a sample is drawn from all batches for analysis in plant laboratories.

There are specific compositional and property values outlined in each specification for the guidance of the manufacturers and the analyst. Many of the early deliveries were returned after discussion with the paint suppliers, for being considerably off specifications. Returns are now rare. Slight deviations are not considered sufficient cause for return; however, vehicle-solids and pigment-content deviations to the low side are viewed with alarm. One occasion, overcooked varnish was detected which, if applied, would yield worthless coatings.

During extremes of weather—viz., heat, cold, and high humidity—solvents are added to the paints in the field to speed or slow drying time or to improve adhesion to undercoatings. The practice of employing solvent additives has improved aluminum finish coatings and has extended film life through more complete pigment leafing.

Additives—usually at the rate of two to four fluid ounces per gal—supply needed material adjustment where varnish solids are high in quality coatings.

An over-all night view of the modern refinery facilities built by Procon for Ingram Oil and Refining Co. of Meraux, La.

Included in the offsite construction work completed by Procon were dock lines from the storage area of the refinery to the Mississippi River.

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In addition to the process units, a considerable amount of offsite construction was completed by Procon, including buildings, steam generation, water supply and disposal systems, loading racks, and dock lines.

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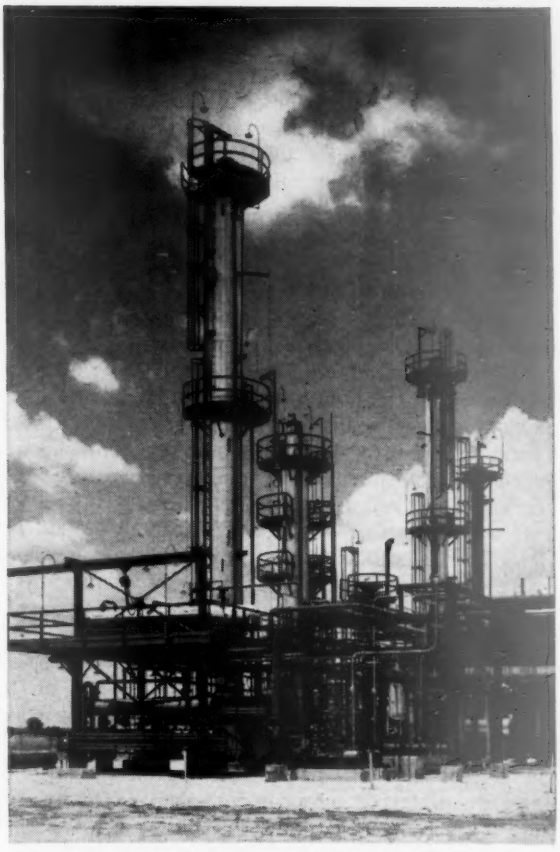

The polymerization plant is an integral part of the refining facilities built by Procon. Immediately adjacent to these columns will be found the gas concentration plant.

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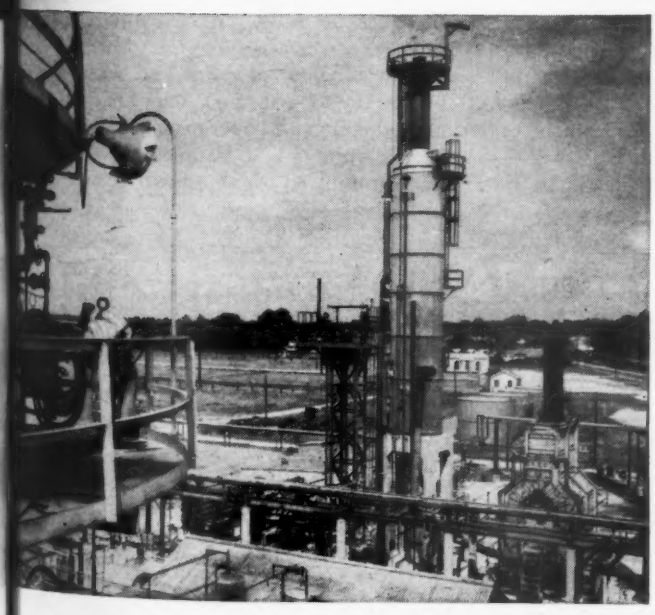


The vacuum unit tower rises in the background. To the right of the tower can be seen the vacuum heater, and in the foreground, the "cat" cracker.

The UOP Fluid Catalytic Cracking unit as seen from a portion of the large tank farm at the new and modern refinery of Ingram Oil and Refining Co.

The solvent evaporation rate must be fast enough to agitate the aluminum flake in the varnish under varying conditions. The inspector handles all additives for Shell Oil Company and contractors' forces at the job site. For obvious reasons Shell also supplies specification materials for contracted work.

Application

One of the first steps undertaken in this phase of atmospheric-corrosion mitigation was a study of surface preparation. Hand-cleaning tools were supplemented with pads of heavy grit papers that improved surfaces and reduced cleaning time. Power tools have not been exploited due to the sparking hazard. Because of more satisfactory cleaning, sandblasting is preferred where sparks are not a hazard.

A review of blasting sands found none better than the Ottowa sawing type already in use. This is a highly graded product, 70 per cent of which passes through a U.S. standard 40-mesh sieve. The cost is approximately $5 per ton in bulk and $10 per ton in bags. Bags are preferred where mechanical handling facilities exist. Bulk handling substantially exceeds the $5 differential between the 2 types of shipment.

A blasting trailer-mounted machine was rebuilt for 2 outlet lines instead of the previous single line. A 500-cu ft per min compressor was attached with a discharge pressure of 100 psi to 110 psi. The result was a 25 per cent reduction in blasting labor cost, as 1 machine tender could tend the 2 operating hose lines from 1 machine. Two men per nozzle formerly were required. Thoroughness of cleaning on blasted surfaces became important because of the wide variation in costs.

Class two blasting or a slightly clouded finished surface is the desired standard for most environments. Metal white blasting finishes, described as class one, cost virtually twice as much as class two work. To date, the apparent coating life and the satisfactory condition of prime coats do not appear to warrant the better grade of blasting in most of the refineries.

Thin and uneven spray painting was the next problem to be overcome. The first step was instruction of the supervisors and craftsmen in protective-coating objectives. In some cases condensed texts were prepared for the painter craftsmen who were instructed on a classroom basis. Portions of spray-painting films, issued by a spray-equipment manufacturer, also were used in the instructive sessions. The craftsmen proved to be apt pupils both in class and later in the field.

The major points discussed were working with low pressures, and operating the spray guns close to the surface to be coated with the correct gun adjustment for good pattern. The adding of paint to edges, crevices, and irregular areas with the guns held at right angles to the surfaces being painted was emphasized. Because of surface-preparation cost and repainting frequencies, the economics of an exterior coating system dictate reduced spreading rates or the maximum possible wet-film application without sags or runs.

Stage rigging was changed to provide suspension of stages from pipe or wheel rollers operating on the edge of the roof. Rollers are held at the rim by means of cables back to center fixtures in the roof of the tank. In the event of off-center fixtures, a chain block is installed in the cable system and payed out or pulled in as required during progress around the tank. With the rolling suspension equipment the practice is to start work by pulling the stage to the top ring of the tank. Two painters are on the stage, with a man on the roof who pulls the coupled rollers along the edge as work progresses on the side.

Pulling from, say, the tank stairway to the foamite lines will provide continuous travel for the stage of one-third to one-half of the tank circumference. On arrival at the foamite lines the stage is lowered one ring for the return trip to the stairway and for painting in transit. This method cuts stage lifts to the minimum, is less wearing on the personnel, and adds to the time in which spray painting actually is being done.

The greatest single innovation probably is the paint pump, which now is available from several manufacturers. The reciprocating type is preferred as it only operates when a spray gun is open. The medium-sized units are capable of a maximum discharge pressure of 550 psi on an input of 100 psi of air to the drive cylinder. The pumps can be throttled down to normal painting pressures—20- to 60-psi discharge—by means of diaphragm control on the inlet air to the driver.

These pumps can best be described as similar to those used in service stations to grease automobiles. Attached to the rim of open barrels used for paint reservoirs, the pump foot valve is immersed in paint. Paint supply can be replenished at any time during spraying—without a shutdown—as the reservoir is not under pressure.

For tanks the pump and barrel reservoirs are placed at a convenient roadside spot or in a paint trailer located at roadside. Paint deliveries from warehouse stock can then be brought alongside with a minimum of handling. The reservoir is filled, the pump is set at the desired discharge pressure, and the hose is pulled off a reel with the paint supply being fed from the pump through the reel hub shaft to the hose. The hose lines and spray guns are the only equipment to go over the fire wall to distant tanks. Four spray guns have operated successfully from one pump at distances up to 1200 ft and 48 ft high on tank roofs. The ¾-in. discharge hoses are reduced to ⅜-in. hoses by means of Y connections for the last 100 ft to permit multiple-gun operation.

In operating units which require a general repainting, the practice is first to clean the surfaces and do the necessary spot priming. After all cleaning and priming have been completed, the pump is situated at the plot edge where supply trucks have access. Again the reservoir is filled, and the hose line is pulled out as necessary for 2 to 4 guns to spray the entire unit. Paint has been pumped as high as 150 ft in operating areas.

Whenever painting operations are to continue the next day, the hose lines are left stretched out and under pressure. The guns are dropped into a pail of distillate to prevent the material from hardening on gun tips. This practice saves daily equipment-cleanup time.

The carrying of paint and pressure pots to the tops of tanks, over fire walls, and throughout operating units has been eliminated. It is noteworthy that there is no need for shutdown of spray-

TABLE 4. Coating systems.

Coat	Specification material	How applied	Thickness (mils)
A. Sandblasted surfaces — tanks and structurals:			
1. First prime	19-1.11	Spray	1.5
2. Second prime	19-1.12	Spray	1.5
3. First finish	Black or aluminum	Spray	1.5
4. Second finish	Black or aluminum	Spray	1.5
B. Hand-cleaned surfaces — tanks and structurals:			
1. First spot prime	19-1.13	Brush	1.0
2. Second spot prime	19-1.12	Brush	1.5
3. First finish	Black or aluminum	Spray	1.5
4. Second finish	Black or aluminum	Spray	1.5
C. Hand-cleaned or sandblasted bare piping:			
1. Prime coat	19-1.13	Brush or spray	1.0
2. Second coat	Equal parts 19-1.12 plus phenolic black	Brush or spray	1.5
3. Finish coat	Black or aluminum	Brush or spray	1.5
D. Hand-cleaned or sandblasted equipment: There are no particular systems developed in this case. Generally, equipment can be classified as falling in one of the three foregoing systems, depending on skin temperature.			

ing to replenish the paint supply.

Another essential tool added was the dry film gage. The permanent magnet type in pocket size is most practicable for widespread field use. The practice of constant inspection and the use of the film gage have resulted in fairly uniform coatings with the desired minimum thickness of 1.0 mil per coat. The average film thickness for a 4-coat system is approximately 5.5 mils. This appears to establish the value of inspection and application control.

In general, specification materials are applied in specific systems outlined in Table 4.

The reasoning on the pipe-coating system is that piping is more uniform in temperature, generally warm, and corrosion rates are low. Heavy protective coatings normally are not necessary.

Insulated equipment and piping are primed with 2 coats under the insulation if the operating temperature is less than 220 F. Surfaces above this temperature under insulation remain unpainted. It has been found that corrosion occurs on insulated surfaces at temperatures up to approximately 220 F. Two coats of inhibitive primer before insulating seem to check the attack.

The objective is one of maximum film thickness compatible with good economics and severity of environment. Film thickness is proving to have a direct relationship to surface protection and coating longevity. In any event, paint systems cannot be preconceived for all surfaces in the refineries. The paint engineer must exercise judgment in the recommendation of coating systems or special materials whenever corrosion indicates a need.

Figs. 1, 2, 3, 4, and 5 are scenes of typical field procedure for sandblasting and applying the first prime coat.

Evaluation

Although the problem of atmospheric corrosion is far from concluded, favorable results are becoming apparent on the basis of the program thus far. An outline of direct costs per unit of large storage-tank surfaces in one of the refineries will best illustrate progress.

In 1948 an average of $24 per square (100 sq ft) was expended to sandblast and to apply 2 coats of proprietary paint on new steel. The labor and material ratio was 4:1, and coating life was 2.5 years. Dry film thickness was unknown but, at best, it could not have exceeded 2 mils. The mean cost per year of film life was $9.60. In most cases the single coat of inert primer was in a generally failed condition and required replacement.

Since the program was inaugurated in 1948, the painter has had an hourly

TABLE 5. Tank protective-coating record.

Size: 120 ft by 40 ft — Tank No.: A-114

Job started: 1-6-53 — Completed: 4-7-53 — Department: Dispatching north property

Job done by: Shell ☐ Contractor ☐

Foreman: Heinemeier — Inspector: Sparks

Type of job: New work ☐ Repainting ☐ Touch-up ☐

Environment: North property, isolated area, remote from general refinery; effluent: pH 7+

Average weather conditions: Temperature: 20 F to 100 F — Relative humidity: 30 to 75

Surface preparation — method: Class B sandblast

Materials Used

(The name of supplier, formulations' batch numbers, laboratory and inspection reports attached.)

Shell: Size: _____ Surface area: _____ sq ft

Rust Inhibitor:	Description	How applied	Number of gallons	Thickness (mils)
First coat	Shell 19-1.11 primer	Spray	54	1.5
Second coat	Shell 19-1.12 primer	Spray	58	3.0
Third coat	Shell 19-1.21 aluminum	Spray	45	4.5
Fourth coat	Shell 19-1.21 aluminum	Spray	45	5.5
Miscellaneous				

Roof: Type: _____ Surface area: _____ sq ft

Rust Inhibitor:	Description	How applied	Number of gallons	Thickness (mils)
First coat	Shell 19-1.11 primer	Spray	41	1.5
Second coat	Shell 19-1.12 primer	Spray	46	3.0
Third coat	Shell 19-1.21 aluminum	Spray	36	4.0
Fourth coat	Shell 19-1.21 aluminum	Spray	38	5.5
Miscellaneous				

General Remarks

Finished appearance one of uniform application. VMP* naphtha added to aluminum paint to improve leafing — 3 oz per gal

Inspection Report

Date		Inspector
2-26-54	General appearance good, no corrosion evident	W. W. Culp

Prepared by: E. L. Sparks — Date: 4-7-53

* Varnish makers and painters.

TABLE 5 (Cont.) Tank protective coating cost record.

Roof type: Cone — Tank No.: A-114 — Size: 120 ft by 40 ft

Job order No.: 9800-2 46-52573 — Started: 1-6-53 — Completed: 4-7-53

Material

	Shell (Sq ft 15,000)		Roof (Sq ft 11,300	
Abrasive	26 tons at $11.60	$302.00	12 tons at $11.60	$139.00
Inhibitor	— gal at —	—	— gal at —	—
First coat	54 gal at $4.12	$222.00	46 gal at $ 4.12	$189.00
Second coat	58 gal at $ 4.93	$286.00	46 gal at $ 4.93	$227.00
Third coat	45 gal at $ 3.50	$158.00	36 gal at $ 3.50	$126.00
Fourth coat	45 gal at $ 3.50	$158.00	38 gal at $ 3.50	$136.00
Miscellaneous material	— gal at —	—	— gal at —	—
Total		$1126.00		$817.00

Labor

	Hours	Rate	Total	Hours	Rate	Total
Sandblast	112	$2.37	$266.00	60	$2.37	$142.00
Inhibiting						
First coat	40	$2.37	$ 95.00	20	$2.37	$ 47.00
Second coat	64	$2.37	$152.00	24	$2.37	$ 54.00
Third coat	48	$2.37	$114.00	24	$2.37	$ 54.00
Fourth coat	48	$2.37	$114.00	24	$2.37	$ 54.00
Rigging	8 each at 2.37+2.17		$ 36.00			
Hauling	40 deg at 2.09+1.89		$139.00			
Miscellaneous						
Total			$906.00			$351.00

Summary

Area: Shell: 15,100 sq ft; Roof: 11,300 sq ft; Total: 26,400 sq ft

Cost: Material — Shell: $1126.00; Roof: $817.00. Labor — Shell: $906.00; Roof: $351.00. Overhead and fee:* $3200.00. Total costs:

Labor and material / Square feet = $3200 / 26,400 = $.122 cost per square foot

Prepared by: E. L. Sparks

Date: 4-8-53

Tank No.: A-114

* If by contract.

rate increase of more than 24 per cent. The current average expenditure is $10 per square to sandblast and to apply 4 coats of paint on new steel. The labor and material ratio is approximately 1:1, and dry film thickness is from 5.5 mils to 6.0 mils. Subsequent coating measurements on many surfaces indicate a minimum life of 7 years. On this basis the cost per square per year will be $1.43.

It is anticipated that the lead prime coats will not require renewal for the life of the tank, provided that new weather coats are applied when needed. Spot priming and 2 finish coats currently are being applied for a maximum of $6 per square, which should yield another 7 years of weather-coating life. On completion of the second paint cycle (14 years total), the unit cost per year of life would be $1.14.

A cost breakdown for sandblasting and applying 4 coats on a 16-tank project is outlined in Table 6.

TABLE 6. Cost analysis.

16 — New tanks painted*
Total sq ft — 260,239
Total cost — 24,069.04

	Sand blasting	1st coat	2nd coat	3rd coat	4th coat	Rigging	Hauling	Misc. labor†
Labor	3676.15	1698.27	1944.38	1601.38	1768.00	345.02	1033.74	302.80
Material	1560.05	3040.85	3247.78	1890.92	1959.70	—	—	—
Total	5236.20	4739.12	5192.16	3492.30	3727.70	345.02	1033.74	302.80
Per cent labor	70.0	36.0	37.0	46.0	47.0	100	100	
Per cent material	30.0	64.0	63.0	54.0	53.0	—	—	
Per cent total cost	21.7	19.7	21.6	14.5	15.5	1.4	4.3	1.3
Total labor	12,369.74				51.4			
Total material	11,699.30		Per cent of 24,096.04		48.6			
Total cost	24,069.04							
Total square feet	260,239		Cost per square‡—9.20					

* Plant overhead not included.
† Labor for removing sand from floating roofs.
‡ Square = 100 sq ft.

Conclusion

In conclusion, it must be pointed out that all of our coatings are not faultless. Coating repairs have been made on a spot basis in a few instances such as wind-girder edges, thin areas, and tank stairways. However, specification materials, trained craftsmen, good surface preparation, and application of sufficient film thickness—coupled with aggressive inspection and supervision—are yielding favorable results. Fig. 6 shows the relative cost decrease and the longevity increase for our 4-coat system on tanks. The best progress measurement is the extent of protection afforded at low unit cost per year of coating life.

SHELL STANDARD 19-1.11*

General Requirements

Condition in container: The paint shall be well ground, shall show no skinning in a freshly opened full can, nor settle badly, liver, gel, or cake in the container. It shall be capable of being readily broken up with a paddle to a smooth uniform paint.

Working properties and appearance: The paint shall have good brushing properties, shall work easily, shall possess good leveling, and shall dry to a uniform, smooth eggshell-gloss finish without streaking, running, or sagging.

Composition

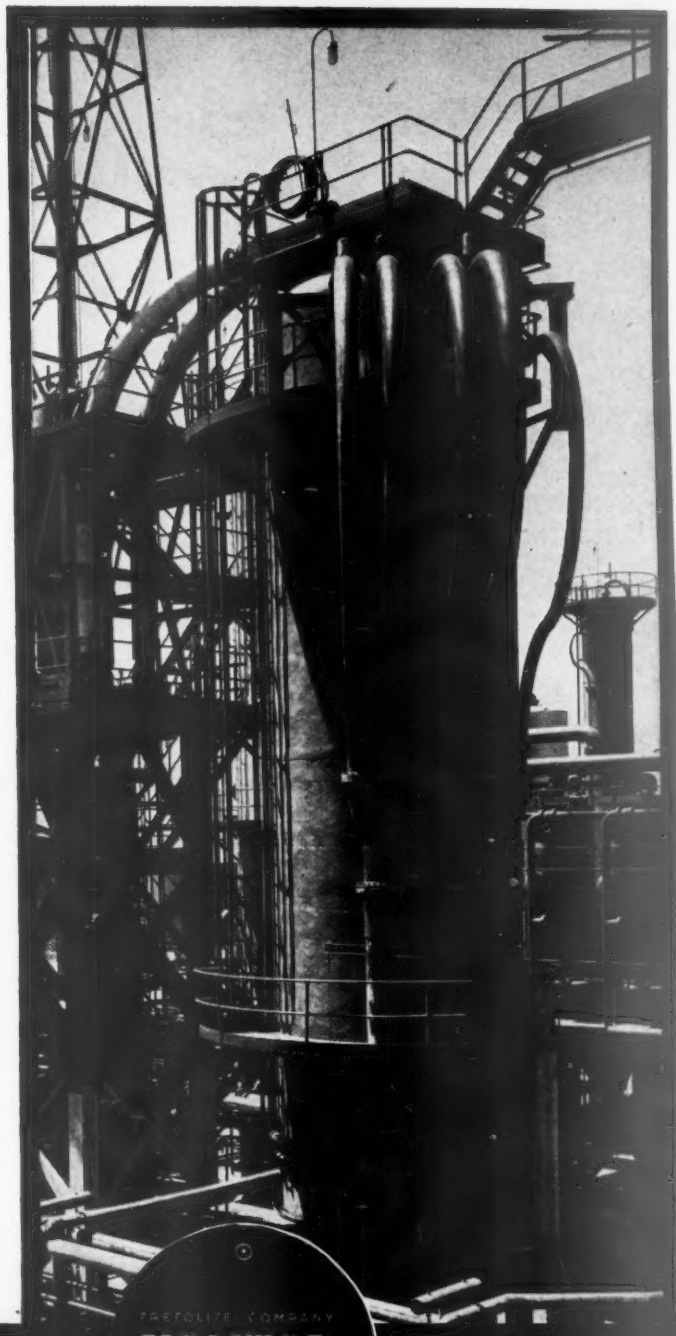
Pigment: The proportions of the various pigments on a percentage-by-weight basis shall be as follows:

	Per cent by weight	
	Minimum	Maximum
Red-lead (97 per cent grade)	65.0	....
Red iron oxide (85 per cent grade)	15.0	17.0
Magnesium silicate	....	14.7
Mica (325-mesh)	4.0	6.0
Aluminum stearate	....	0.3

The extracted pigment on analysis conform to the following quantitative requirements:

*Red-leaded mixed-pigment alkyd-varnish linseed-oil paint. (Meets federal specification TT-P-86a, type 2).

HOW MUCH DOES CORROSION INCREASE YOUR MAINTENANCE COSTS?



Corrosion takes a heavy toll throughout the entire oil industry. In the refinery, handling large volumes of oil at high temperatures, the cost of replacing damaged metal equipment is greatest. It has been estimated that the overall cost of corrosion to refiners is as much as $250,000,000.00 per year, *not including the cost of shut-downs and lost on-stream time!*

Losses in such magnitude reflect tremendous metal loss, equipment damage and maintenance expense. Unless you carefully use every means at your command to combat corrosion, your refinery may be carrying an undue share of this economic burden.

Why not get all the facts on the use of Kontol Corrosion inhibitors in the refinery? They may help you cut your maintenance costs substantially.

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XUM

FIG. 1. View of sandblasting a side wall of a large tank.

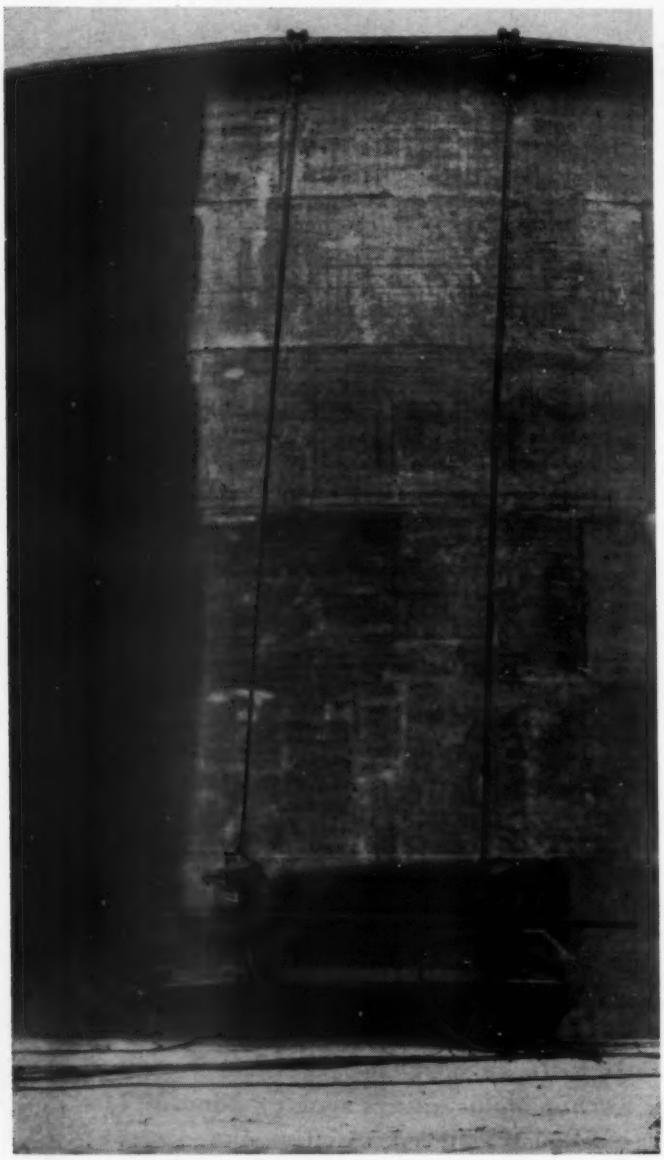


FIG. 2. Rolling stage supports of a painting platform, on the rim of the tank wind girder.

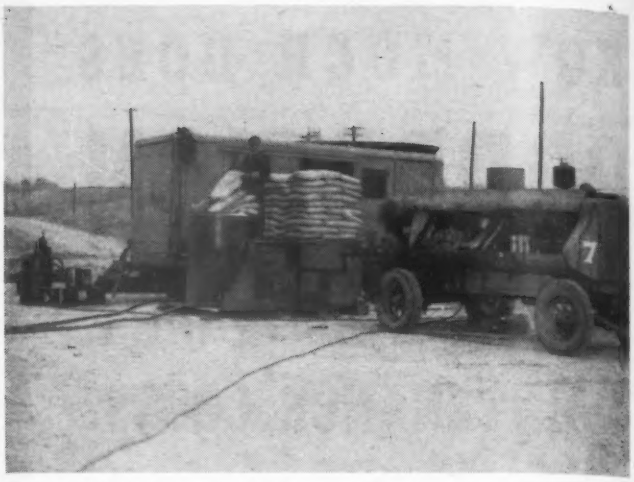


FIG. 3. New 21-cu ft sand blaster with two hose outlets and double controls.

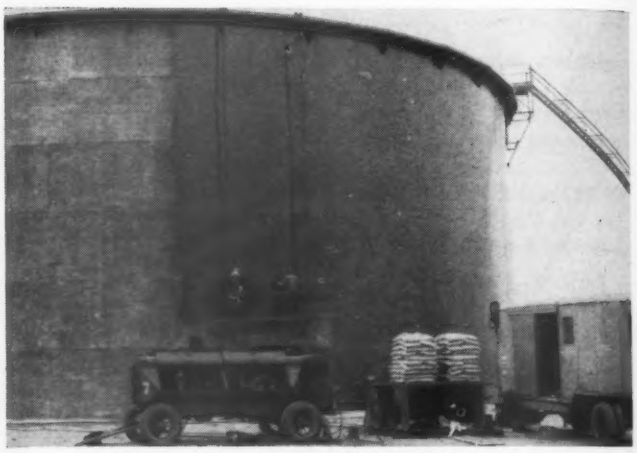


FIG. 4. Rig-up for spray painting first prime coat on a sandblasted surface.

FIG. 5. Setup of an air-driven spray-painting pump in action at job site.

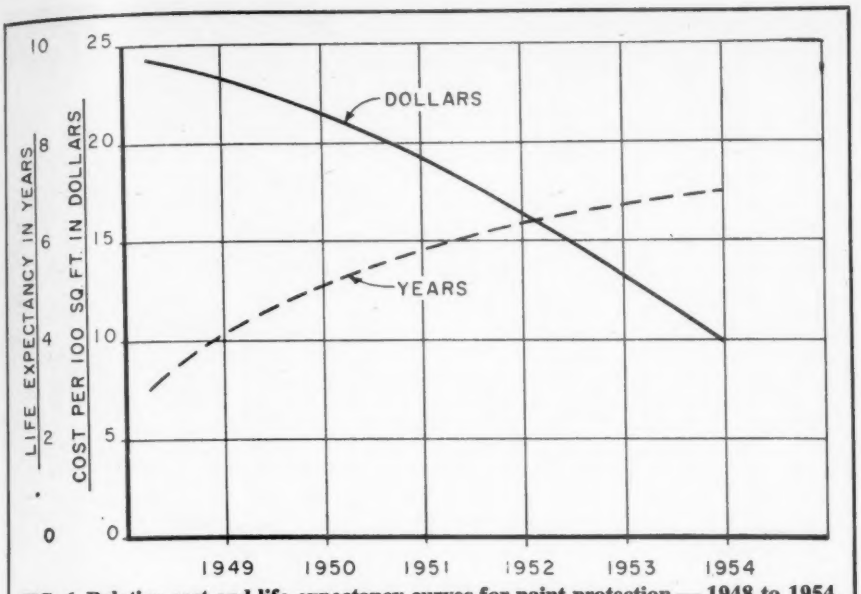


FIG. 6. Relative cost and life expectancy curves for paint protection — 1948 to 1954.

	Per cent by weight	
	Minimum	Maximum
True red-lead (Pb_3O_4)	63.0	....
Iron oxide (Fe_2O_3)	13.0	....
Siliceous	....	22.0

Vehicle: The vehicle shall consist of raw or alkali-refined linseed oil, blended with a glyceryl-phthalate-type varnish composed of a linseed-oil modified resin (30 per cent phthalic-anhydride minimum), together with the driers and volatile mineral spirits.

The vehicle shall be free from rosin and rosin derivatives. It may contain addition agents and shall have the following proportions on a percentage-by-weight basis:

	Per cent by weight	
	Minimum	Maximum
Raw or alkali-refined linseed oil	28.0	....
Alkyd-resin solids	28.0	....
Volatile mineral spirits and drier	....	44.0

Paint: The finish paint shall conform to the following composition and property values:

	Minimum	Maximum
Pigment, per cent by weight	66.0	....
Vehicle, per cent by weight	....	34.0
Vehicle solids, per cent by weight	56.0	....
Phthalic anhydride content of non-volatile vehicle, per cent by weight	15.0	....
Uncombined water based on total paint, per cent by weight	....	0.5
Coarse particles and skins (total retained on 325-mesh sieve based on paint), per cent by weight	....	1.0
Weight per gallon, pounds	16.7	....
Consistency* (package)	....	....
Kerbs-Stormer shearing rate	....	....
Viscosity at 200 rpm:		
Grams	155	255
Equivalent Krebs units	73	89
Drying time (hours):		
Set to touch	....	4
Dry through	....	16
Fineness of grind	3½	....

Applicable Specifications

In order to obtain paint that will meet the specified requirements, the raw materials used should conform to the following specifications:

Red lead	ASTM D83-41
Magnesium silicate	U. S. Navy 52-M-2c, type B (fibrous)
Mica	ASTM D607-42
Aluminum stearate	U. S. Navy 52-A-12a
Raw or alkali-refined linseed oil	ASTM D234-48
Alkyd-resin solution	Federal specification TT-P-266, type 3
Mineral spirits	ASTM D235-39
Driers	U. S. Navy 52-D-7

Red iron oxide shall meet the following compositional requirements:

	Per cent by weight	
	Minimum	Maximum
Ferric oxide	83.0	....
Silica	....	9.0
Calcium oxide	....	4.0
Sulfates (calculated as SO_3)	....	1.0
Moisture at 105 C	....	1.0
Soluble salts	....	1.0
Fineness (retained on 325 mesh)	....	1.0
ASTM oil absorption	12.0	17.0
Specific gravity	4.1	4.5

Methods of Test

All testing of raw materials shall be done in accordance with methods outlined in the applicable ASTM or other specifications for the materials. The paint shall be tested according to the following methods outlined in federal specification TT-P-141b.

Test	Method
Volatile and non-volatile content	404.1
Per cent of pigment	402.1
Isolation of vehicle	403.1
Vehicle solids	405.1
Phthalic anhydride	702.1
Oil acids	703.1
Iron oxide (Fe_2O_3)	714.1
Uncombined water	408.1
Coarse particles and skins	409.1
Consistency (Krebs-Stormer)	428.1
Set-to-touch time	406.1
Dry through	406.1
Fineness of grind	441.1
Condition in container	301.1
Brushing properties	205.1, 432.1
Skinning	414.1
Rosin and rosin derivatives	503.1†
Weight per gallon	401.1
Flash point	429.3

Test for true red-lead and siliceous extender and mica. Transfer 0.50 g of the pigment to a 400-ml beaker. Add 15 ml of concentrated hydrochloric acid, and heat gently until the iron oxide and red lead are completely dissolved. Evaporate to dryness, and bake at 105 C to 110 C for 1 hour.

Moisten the residue with a few drops of concentrated hydrochloric acid; dilute to 100 ml with hot water; and boil, filter, and wash with hot water. Transfer the paper and contents toa weighted porcelain crucible, ignite, cool, and weigh.

Examine the residue microscopically to determine the presence of mica. Calculate the percentage, and report this residue as the siliceous extender and mica.

To the filtrate and washings add 20 ml of sulfuric acid (specific gravity, 1.84) and evaporate to sulfate (SO_3) fumes.

Cool, add 150 ml of water and 150 ml of 95 per cent ethyl alcohol, let stand cold for 2 hours, filter on a gooch crucible, wash with 15 ml of 50 per cent alcohol followed by 95 per cent alcohol, dry at 105 C to 110 C, and weigh as lead sulfate. Calculate to true red lead (Pb_3O_4).

Paint which meets this specification is intended for use as a prime coat on new unpainted metal.

A typical formula for paint that meets this specification can be made using the following percentages by weight of the materials specified previously herein:

Red lead	43.16
Iron oxide	10.62
Magnesium silicate	9.76
Micaceous pigment	2.66
Aluminum stearate	0.20
Glyceryl-phthalate varnish	18.98
Raw or alkali-refined linseed oil	9.44
Mineral spirits	4.84
Lead naphthenate	0.24
Cobalt naphthenate	0.10
	100.00

This formulation will give a paint which weighs approximately 17 lb per gal, and has an approximate pigment volume of 38. The desired pigment-volume range is 35 to 39.

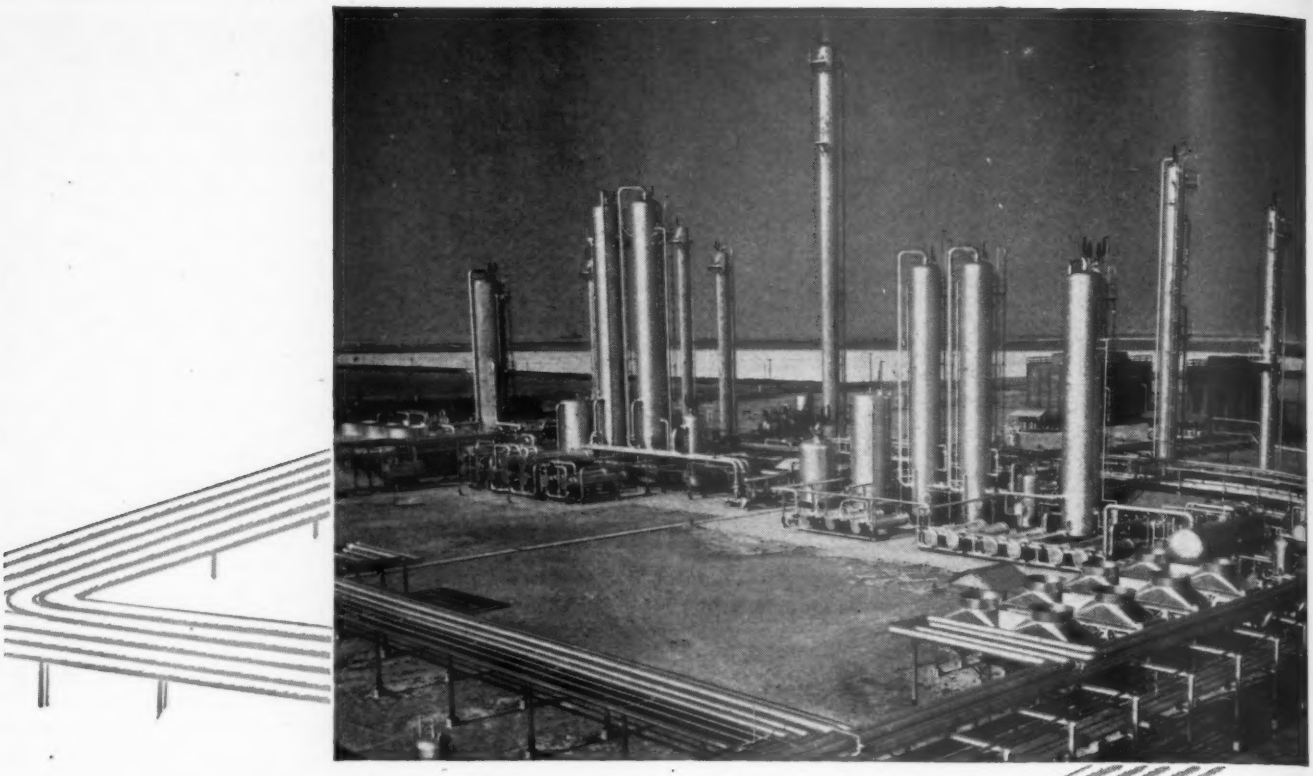
If thinning is necessary for spray application, the addition of turpentine or volatile mineral spirits, up to ¾ pt per gal of paint, may be made.

Paint shall be subjected to standard physical and chemical tests at destination to insure conformance with specifications. Shipments rejected shall be returned, for full credit, at manufacturer's expense.

Paint containers shall be labeled, with standard number, type of paint, and date of manufacture marked thereon.

*This determination shall be made not sooner than 48 hours after manufacture of paint.

†Make the test on a portion of the isolated vehicle.



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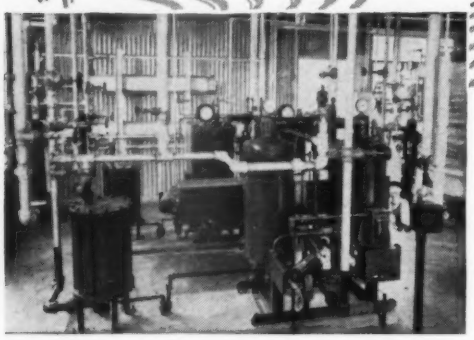

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Hydrogen Chloride From Crude Oils vs Salt Content†

G. J. SAMUELSON

BECAUSE of the increasing importance of corrosion in refinery equipment, an investigation to determine the relationship between salt content of crude petroleum and evolution of hydrogen chloride on distillation of the crude oil was undertaken. Four representative oils, each typical of extensive production in widely separated areas, were desalted to varying degrees, and the raw and desalted samples were then distilled in the laboratory under simulated refinery conditions for the purpose of determining the amounts of hydrogen chloride evolved, as a measure of potential corrosion.

Studies of a similar nature have been recorded previously. Davis, Jones, and Neilson,[1] in an excellent comprehensive discussion on control of corrosion in distillation equipment, reported data on hydrogen-chloride evolution from crude oil. These authors asserted that the rate of corrosion by hydrogen sulfide is greatly accelerated by the presence of traces of hydrogen chloride. This was explained on the basis of a cyclic reaction within the vapor and condenser system; i.e., in this reaction hydrogen chloride attacks the iron, giving ferrous chloride; the latter reacts with the hydrogen sulfide to free the hydrogen chloride for further attack.

Our own laboratories have extensively examined the theoretical and practical aspects of acid evolution on crude distillation; formerly they carried out routine distillations of crude oils in connection with desalting services. The published data[2] resulting from these studies are of interest to refiners. As previous work on this subject was not primarily concerned with the effect of various amounts of salt in a single crude, it was the purpose of this investigation to study the acid evolution from four typical crude oils, each over a broad range of salt concentration.

Method of Analysis

The crudes were subjected to electrical desalting procedures—in part, in existing commercial plants; in part, by laboratory methods—so as to provide samples with the desired range of salt content. They were then distilled to a temperature of 650 F, under a controlled time schedule during which a specified amount of steam was admitted.

The distillation procedure was an elaboration of the method of Davis and his co-workers,[1] and is described in detail by Roberts, Stenzel, and Eberz,[2] as well as in an analytical manual on salts in petroleum.[3] The aqueous distillates were then examined for chlorides by appropriate electrometric titration with silver nitrate. Similar distillations were also performed on each sample, but in the presence of concentrated phosphoric acid, for the purpose of evolving and determining quantitatively the total chlorides actually present in the crude oil. Aqueous extractions by special methods (the latter involved resolution of emulsions by electrical and chemical means) were also performed on the crudes to determine extractable chlorides.

In general, it was noted that the steam-phosphoric-acid values for total chloride present were slightly higher than the values by extraction—as would be expected, inasmuch as some of the salts in the oil medium may be difficult to extract. Therefore, the steam-phosphoric-acid values are used as the total chloride present in the crudes in the data that follow. The values by extraction are included for the purposes of comparison for the reason that chlorides are more commonly determined by this method in refining laboratories.

Various other pertinent data on the crude samples, determined by suitable methods, are shown in Table 1. Organic acidity was determined by electrometric titration of a 25-ml sample of crude oil, in xylene-secondary-butanol-water mixture, with alcoholic potassium hydroxide, taking a pH of 11 as the end point.[4] A combination of extraction, filtration, and ashing methods was employed to determine inorganic components, using spectroscopic and polarographic methods.

In the steam distillations 500 ml of crude oil, measured by weighing it directly into the special distillation apparatus, was heated gradually over a period of 55 min to the 650 F end point. During the latter 45 min of this period dry steam was admitted to the distillation flask near the bottom of the oil layer at a constant rate such that the total introduced was 40 grams. In the steam-phosphoric-acid distillations the procedure was the same, except for the addition to the flask of 35 ml of 85 per cent chemically pure phosphoric acid. In all distillations, as

TABLE 1. Summary of data on raw and desalted crude oils.

	Crude-oil sample no. and type	Organic acidity (ptb as NaOH)	Inorganic components (ptb as such)						Water by distillation per cent	Total chlorides (ptb as NaCl)		Chlorides evolved on steam distillation	
			Mg	Ca	Na	Fe	Cl—	SO_4=		By extraction	By steam (phosphoric-acid-distilled)	ptb as NaCl	Per cent of total
8	West Texas, raw	69.7	0.4	6.1	66.9	18.2	86.8	14.0	0.20	141.9	142.9	14.6	10.2
11	West Texas, desalted	14.9	<0.1	<0.1	10.9	27.2	8.6	9.6	0.50	15.0	14.2	5.5	38.7
10	West Texas, desalted	14.9	<0.05	<0.05	2.6	16.7	2.4	...	0.23	2.5	3.9	3.9	100
6	West Texas, desalted	12.5	<0.05	<0.05	2.4	33.0	1.1	...	0.12	1.5	1.8	1.7	94.5
9	West Texas, desalted	3.8	<0.05	<0.05	2.4	10.5	0.8	...	0.03	0.2	1.3	1.5	(100)
7	West Texas, desalted	6.0	<0.05	<0.05	0.8	20.2	0.3	...	0.11	0.2	0.5	0.5	100
12	Hockley, raw	70.0	6.2	26.0	91.0	12.5	191.5	11.2	0.36	312.0	315.0	35.3	11.2
12N*	Hockley, raw	266.0	6.2	26.0	91.0	12.5	191.5	11.2	0.36	312.0	315.0	47.8	15.2
15	Hockley, desalted	26.5	0.4	<0.1	4.9	6.9	7.8	7.2	0.38	12.2	12.8	7.3	57.0
14	Hockley, desalted	28.0	<0.05	<0.05	0.7	8.7	3.0	...	0.40	4.8	5.0	4.0	80.0
16	Hockley, desalted	21.4	0.2	<0.05	0.6	2.8	1.8	...	0.02	3.1	2.9	2.3	79.4
13	Hockley, desalted	27.5	<0.05	<0.05	2.6	40.2	1.6	...	0.05	1.4	2.6	2.5	96.2
33	Kansas, raw	34.4	<0.1	0.1	5.9	75.6	7.9	16.4	0.09	10.5	12.9	9.9	76.7
34	Kansas, desalted	38.4	<0.05	<0.05	2.2	11.3	2.1	...	0.45	2.8	3.4	3.3	97.1
35	Kansas, desalted	30.9	<0.05	<0.05	2.6	6.8	1.3	...	0.65	1.1	2.2	2.0	90.9
42	Redwater, raw	32.2	0.2	1.5	13.6	2.4	28.4	12.8	0.04	43.5	46.8	22.3	47.6
44	Redwater, desalted	32.2	<0.1	<0.1	5.5	2.6	8.8	4.2	0.80	12.2	14.5	13.2	91.0
43	Redwater, desalted	15.0	<0.05	0.05	5.0	5.7	4.1	...	0.04	2.5	6.8	5.0	73.5
45	Redwater, desalted	30.0	<0.05	0.1	1.5	2.4	3.5	...	0.94	4.1	5.7	5.0	87.6
46	Redwater, desalted	23.5	<0.05	<0.05	0.4	2.3	2.7	...	0.43	3.2	4.5	3.9	86.7

* Represents sample 12 modified by addition of naphthenic acids.

Notes: Crude-oil indentification:
Samples 6 to 11, West Texas sour; API gravity, 41.1 deg.
Samples 12 to 16, Hockley (Texas); API gravity, 30.0 deg.
Samples 33 to 35, Kansas; API gravity, 36.3 deg.
Samples 42 to 46, Redwater (Canada); API gravity, 34.7 deg.
Samples 6 and 7 are from first and second stages, respectively, of a 2-stage commercial electrical desalting installation.
Samples 14 and 43 are from single-stage commercial electrical desalters. All other desalted samples are laboratory, electrically desalted.
The iron in these crudes was present primarily as suspended oxide and sulfide.

†Presented during the 19th Mid-Year meeting of the American Petroleum Institute's Division of Refining, Houston, Texas, May 10, 1954.

well as in other analyses, appropriate blanks were run.

Data and Discussion

Table 1 presents essential data on the individual raw and desalted crude oil samples. The raw samples range in API gravity from 30 deg to 41 deg; in chloride content, from 13 ptb to 315 ptb (pounds of chloride expressed as sodium chloride per 1000 bbl of oil); and in organic acidity, from 32 ptb to 70 ptb (expressed as sodium hydroxide). The desalted samples range in salt value down to a few tenths of a pound per 1000 bbl.

It is evident from this table that the extent of hydrogen-chloride evolution on steam distillation of these crudes varies widely with salt content. The two high salt-content raw crude samples, viz., West Texas and Hockley, show evolution of approximately 10 per cent of the chloride present. The other two, of much lower salt content, evolve considerably larger percentages. It will be noted that, as the salt content decreases —whether the raw or desalted samples are considered—the extent of evolution on distillation rises sharply until, in the low ranges of salt present before distillation, it is essentially complete.

Fig. 1 presents graphically, for the individual crude oils, the relationship between salt concentration and evolution of hydrogen chloride on distillation. Here the salt content is plotted against hydrogen chloride evolved. It is noted that, in the range of less than 10 ptb of salt, the points for the various crudes fall almost on a common curve, thus indicating the essentially uniform character of hydrogen-chloride evolution from these crudes in this salt range.

Fig. 2—in which a single composite curve has been drawn to embrace all

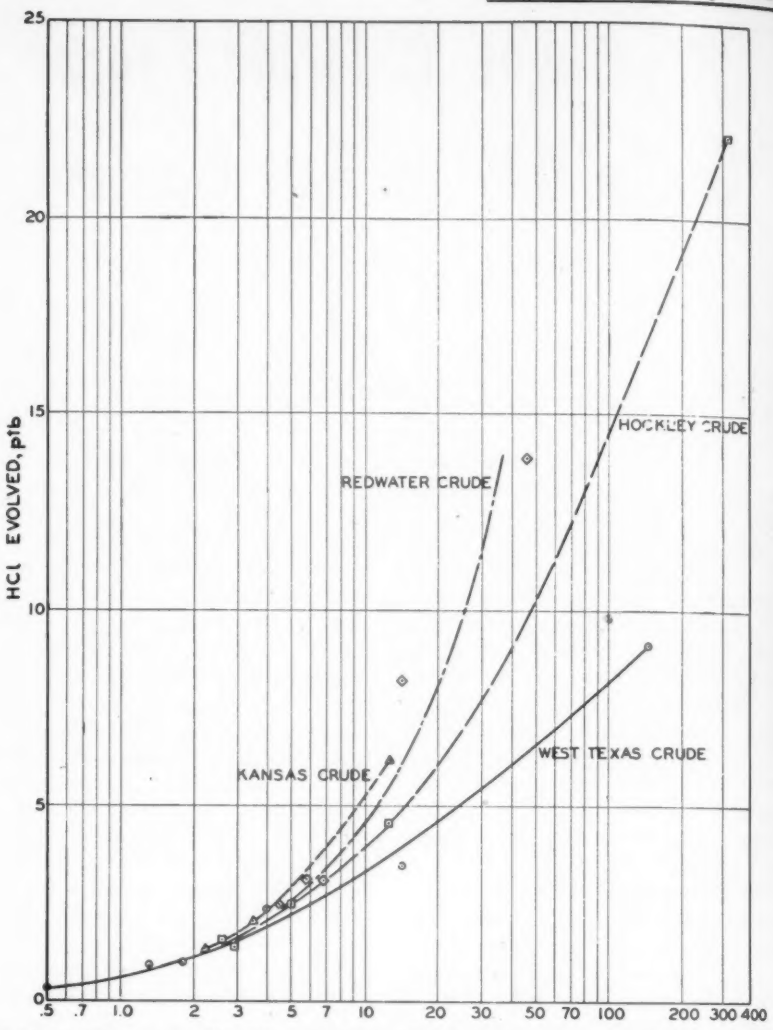

FIG. 1. Hydrogen Chloride evolution related to salt concentration in crude.

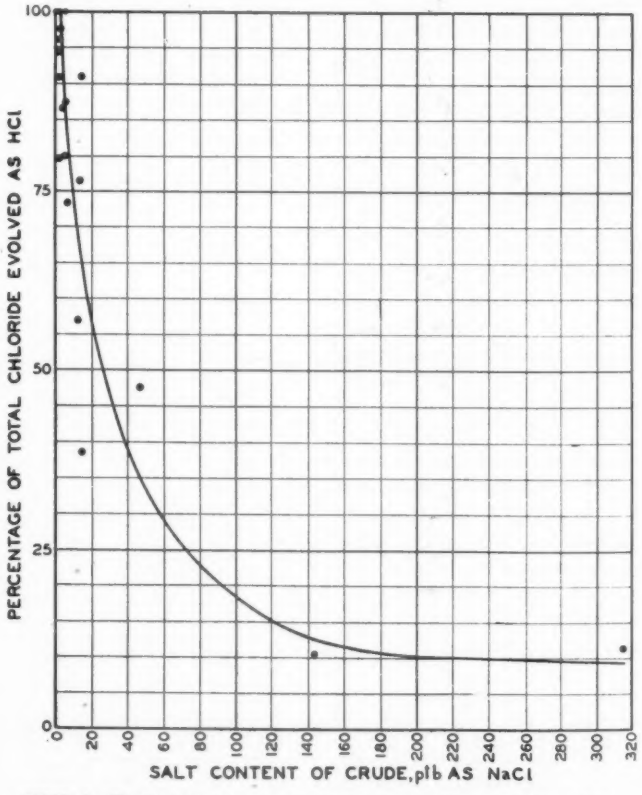

FIG. 2. Total chlorides present vs percentage of this total converted to HCl — a composite of four crudes.

The Author

C. J. Samuelson is research director for the Petreco (electrical) Tretolite (chemical) and wax divisions of the Petrolite Corporation. He joined Petrolite in 1943 at its Petreco division in Long Beach, California. In 1946 he was put in charge of the electrical research activities at the St. Louis, Missouri, laboratories and in April, 1953, assumed his present position.

Samuelson was a member of the staff of the chemistry department at Texas A. & M. College as instructor, assistant professor, and associate professor. He completed graduate work at the University of Nebraska in 1934.

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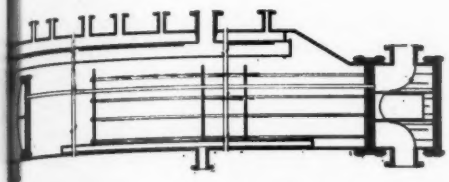

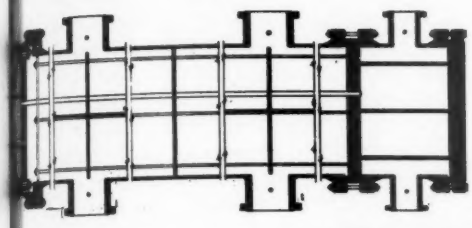

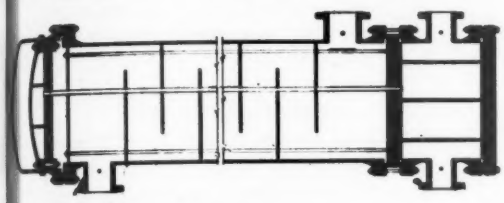

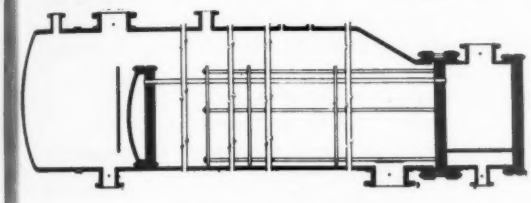

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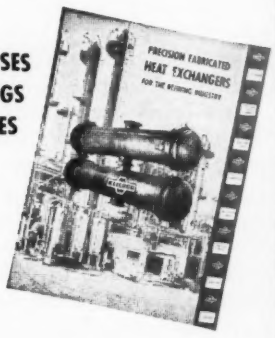

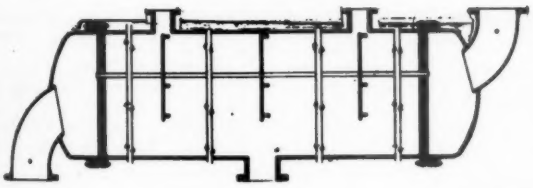

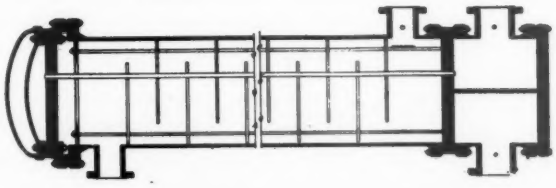

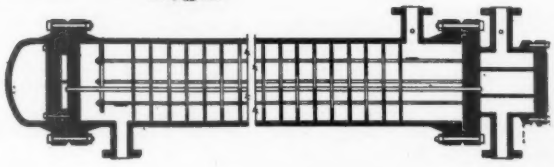

FABRICATED PRODUCTS DIVISION

THE M. W. KELLOGG COMPANY • SUBSIDIARY OF PULLMAN INCORPORATED

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samples, both raw and desalted, of each of the 4 crudes—shows what percentage of the total salt present at the time of distillation may be converted to hydrogen chloride. At 10 ptb, or less, of salt the conversion is in excess of 75 per cent. It is probable, inasmuch as these different crudes behave similarly, that a much larger group would follow the same pattern.

Evolution of hydrogen chloride under these conditions of distillation might result from hydrolysis of certain salts, or from metathetic reactions of the salts with non-volatile acids. The extent of evolution and the nature of the salts (primarily sodium chloride) preclude hydrolysis as the only major factor in the evolution. High-molecular-weight non-volatile organic acids —if present in considerable amount— might, by metathesis at the temperatures encountered, account for much of the hydrogen chloride.

This assumption is borne out by the data (Table 1) which show that addition of naphthenic acids to the raw Hockley sample, before steam distillation, increased the hydrogen-chloride evolution by more than 30 per cent. Possibly selected organic acids of lesser volatility would increase this further. It is postulated that, in crudes of low salt content, the non-volatile organic acidity is sufficient to convert most of the salt present, whereas it is insufficient for higher salt-bearing samples.

Distillations of this type were also carried on relatively pure systems that used refined mineral oil instead of crude oil. In such systems, which contained considerable added sodium chloride, only small amounts of hydrogen chloride could be evolved on distillation, even though appreciable amounts of naphthenic acids were also added.

On the other hand, addition of sodium chloride to the raw Kansas crude —which, on distillation in its unmodified state, yielded 9.9 ptb of chloride (expressed as sodium chloride) (Table 1)—increased the evolution to about 15 ptb, whether naphthenic acids were added or not. Thus hydrogen-chloride evolution is doubtless related to the complex nature of crude oils, and both hydrolysis and metathesis of sodium chloride may be catalyzed by "impurities" present.

To test this possibility, distillations were made on the pure system (refined mineral oil that contained added sodium chloride) to which had been added finely divided iron oxide. In each case, appreciable hyrogen-chloride evolution resulted, whether added naphthenic acids were present or not, thus strongly suggesting the influence of catalysis.

Corrosion of refinery equipment in the distillation of crude oil—although such corrosion results also from other causes, such as sulfur compounds—should certainly be directly related to hydrogen-chloride evolution and, therefore (on the basis of the data in Table 1), to salt content. Some data supporting this statement are available from refinery operations. Table 2, based upon the two-stage commercial desalting installation from which samples six and seven [see footnote to Table 1] were derived, shows how corrosion is related to salt content.

The amount of salt which enters the still is shown during periods of normal two-stage operation and during periods when one of the desalting stages was temporarily out of service. Here the corrosion is measured by the iron content, in parts per million (ppm), of the condensate from the knockout drums following the two towers of the still.

TABLE 2. Plant data which relate degree of corrosion to salt content of crude oil.

Date	Number of desalting stages operative	Salt in charge to still (ptb as NaCl)	Iron (ppm) in aqueous condensate from No. 1 tower	Iron (ppm) in aqueous condensate from No. 2 tower
Feb. 17, 1952....	2	0.5	6	1.1
Feb. 17-20, 1952..	1	4.0	90	24.5
Feb. 22, 1952....	1	4.0	66	22
April 1952.....	2	0.8	2.8	1
April 1952.....	1	4.5	28.2	22

In each case the corrosion was much more severe in single-stage desalting, with attendant higher salt content in the crude. It is not obvious, however, on the basis of the laboratory data, why the reduction in corrosion was so large in relation to the reduction in salt. Perhaps this is the result of more severe conditions of refinery distillations, with resultant greater evolution of hydrogen chloride. Possibly it can be explained on the basis of the cyclic reaction previously referred to herein.

Assuming that distillations such as those described are a reasonably valid reflection of refinery conditions, it is apparent that effective reduction of salt content is necessary to minimize hydrogen-chloride evolution. On the further assumption that the amount of hydrogen chloride evolved is a reliable index of the corrosion of refinery equipment anticipated, the desirability of attaining the best possible salt removal before distillation is obvious.

Salt content of much less than 10 ptb can be of serious consequence because, as stated in one of the references cited,[1] only 3 ptb of hydrogen chloride evolved is sufficient to cause severe corrosion of refinery equipment. The significance of good desalting is emphasized further if these hydrogen-chloride evolution values are translated into terms of iron equivalents in typical refinery operation. Thus a refinery which processes daily 25,000 bbl of crude with a salt content of only 5 ptb might be exposed to the corrosive effect of some 62.5 lb of hydrogen chloride (the equivalent of about 47 lb of iron) per day.

Acknowledgment

The author is indebted to various members of the Petrolite Corporation staff for information and advice in the preparation of this paper, and especially to L. W. Estes and A. D. Franse for assistance in obtaining data.

References

1. Davis, Jones, and Neilson, *The Oil and Gas Journal*, 37 [2] 62 (1938).
2. Roberts, Stenzel, and Eberz, *The Petroleum Engineer*, 10 [7] 144 (1939).
3. *Manual on Salts in Petroleum*, published by Petroleum Rectifying Company (copyrighted) (1946).
4. *The Petroleum Engineer* 10 [8] 65 (1939).

* * *

(This symposium on corrosion will be concluded in an early issue).

Carter Research Building

Carter Oil Company marked 20 years of research by opening its newly enlarged research building at Tulsa, Oklahoma. The huge new center contains 56 rooms, much new scientific equipment, and a 90-ft high research tower where actual drilling research may be conducted.

Project, third major expansion since 1940, increases Carter's research facilities by 50 per cent. A staff of 200 is employed.

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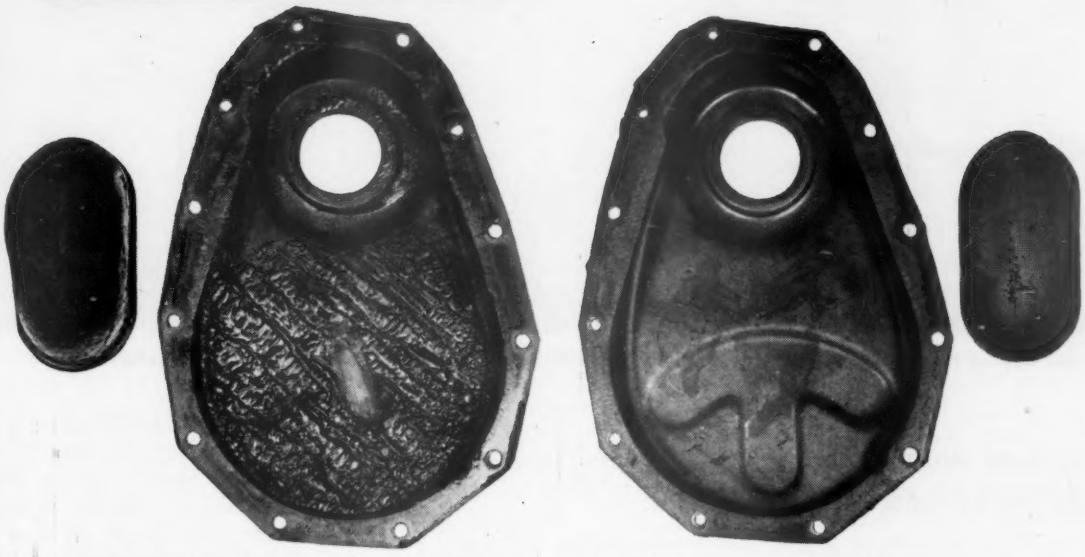

Starting with new engines, a representative number of taxicabs were tested in 50,000 miles of low-duty service (with oil-drain periods at 4500 to 5000 miles) to determine the effectiveness of Du Pont Lube Oil Additive 564. Typical results are indicated by the two sets of photographs above.

Notice the difference in sludge on the oil screen and timing gear cover on the left as compared to the clean appearance of the corresponding parts at the right. Those on the left were operated on a representative heavy-duty motor oil (for service MS and DG). The cleanliness of those on the right resulted from the use of the same base oil to which only Du Pont Lube Oil Additive 564 plus an antioxidant had been added.

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A new solution to engine oil sludge problems, particularly those caused by low-power, low-temperature, and other low-duty driving conditions is now possible. This is especially significant in helping promote your product to the mass passenger car market, and is also of interest to the operators of urban fleets—taxis, buses and delivery services.

The solution of sludge problems is available through the use of new polymeric lube oil additives by Du Pont. Being outstanding detergents and viscosity-index improvers, these double-action additives are exceptionally effective under stop-and-go driving conditions. They are especially effective in retarding sludge formation on all engine parts in contact with lubricating oil. As a result, Du Pont Polymeric Lube Oil Additives help maintain good engine lubrication and extend the useful life of your customers' engines.

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FIG. 1. General view of Pledger (Texas) plant from vicinity of office. At right, main absorbers and dehydrators.

P 773.

By high pressure absorption, then careful reabsorption . . .

Pledger Plant Recovers All Except Odor

ARCH L. FOSTER*

RECOVERY and purification of 5 liquid products and the total residue gas from more than 190,000,000 cu ft of wet Pledger field gas in the central coastal area of Texas is the ambitious job undertaken by Southern Production Company, operator of Pledger Gasoline Plant some 60 miles or so southwest of Houston. Other companies have an interest in this plant.

The plant is designed to process and recover liquid products from 190,700,000 cu ft per day of gas, nearly 187 million cu ft of it wet gas from Pledger field, the remaining 4 million cu ft from Sugar Valley field, nearby. From that gas plans call for the output of the following yields of the products indicated.

TABLE 1.

Fuel Oil	1,910 gal/day
Kerosine	11,310 gal/day
Gasoline, 10 lb. RVP grade	81,335 gal/day
Isobutane	14,150 gal/day
LPG	91,070 gal/day
Sales gas	184,773,000 SCFD†

(†SCFD signifies "standard cubic feet per day)

The wet Pledger field gas comes directly from the wells to the plant at about 2000 psig and about 115 F temperature; Sugar Valley gas arrives at the plant at about 600 psig.

The Pledger gas is stepped down to operating pressure of about 1385 psig by passing through inlet coolers, then expanding in a pressure reducing regulator to have about 75 F temperature when it passes to an inlet scrubber or separator to drop out any liquid hydrocarbons liquefied during the cooling-expanding step. This condensate goes to the high pressure condensate flash tank, and to the condensate surge tank from both of which light vapors flash off and are processed through the reabsorbers. Gas from the inlet scrubber is then sent to the two primary absorbers in equal parallel streams; some 2012 gpm of lean absorption oil is sent to these absorbers to recover the propane and heavier, along with, of course, small amounts of ethane and traces of methane.

The stripped lean gas passes from the absorber tops into a "dry type" dehydration unit, that reduces the water content of the gas to 7 lb per million cu ft. From here the gas stream is sent to sales lines either at 1350 psig or at 1000 psig, as indicated in Table 1. The 500 psig gas stream referred to is obtained largely from residual gas overhead from the high pressure reabsorber, with necessary makeup from the high pressure residue system. The dehydration unit is designed to remove water from 145,000,000 cu ft at 100 F and 1365 psig maximum conditions. Plant fuel gas is taken from low pressure reabsorber overhead residue and any needed make-up comes from the other reabsorber overhead.

Continuing with the rich oil from the primary absorbers, this stream is taken through both the high pressure and the low pressure rich oil vent tanks, the pressures reduced to about 535 and 300 psig respectively. This flashed rich oil, having lost some of its lighter components in these two steps is pressured on to the main oil exchangers, followed by the hot oil flash tank, thence to the direct-fired rich oil heaters and into the primary still. Interestingly enough, the vapor taken off in the hot oil flash tank, is led directly to the primary still, bypassing the heater and going into the still on the same feed tray on which the heated rich oil enters.

Most of the light hydrocarbons are removed in the primary still from the rich oil at essentially 200 psig and the partially denuded oil goes directly to the secondary still and is stripped of its natural gasoline and its overhead stream is totally condensed, all at about 35 psig. Steam is employed for stripping in both stills, and the lean oil is returned to its cooler, and periodically to the purifying still as outlined later. Condensate still excess reflux and the secondary still overhead are combined and sent to the accumulator for the primary still overhead stream, and since these three streams contain only a small amount of methane, the combination goes to fractionation via heat exchangers and to the depropanizer column.

The condensate from the inlet

*Editor, Refining, Petrochemical, and Gas Processing.

EXCLUSIVE

FIG. 2. Still overhead condensers.

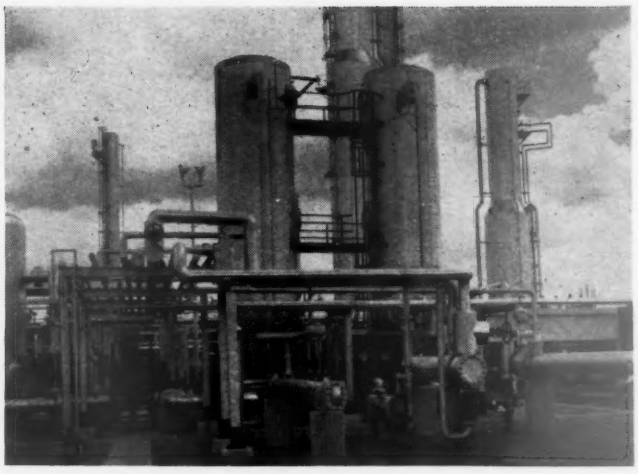


FIG. 3. In foreground; two dry-type dehydrators.

scrubber, pressure on which is reduced, in two stages to about 115 psig goes to an exchanger and then with a small stream of partially stripped oil and a secondary still side stream is led to a direct-fired heater and to the condensate still from which an overhead gasoline-and-lighter stream is taken, the condensate of which goes to the primary still accumulator as noted above. From the condensate still bottom comes a stream of absorption oil-fuel oil mixture that without additional heat goes to the oil purifying still. This stream is heated in a circulatory system, and flashed in the still, heated again, etc., to about 555 F to distill overhead the absorption oil, leaving behind the small amount of fuel oil recovered. This circulation routine is for the purpose of vaporizing overhead the absorption oil without subjecting it or the fuel oil to incipient cracking temperatures, should it be attempted to vaporize all the absorption oil at one pass through heater and still. A small stream is withdrawn from the circulating pump, is cooled in a shell-and-tube unit and sent to storage as fuel oil. The oil purifying still uses about one-third of all the steam destined for the secondary still for stripping, and this steam goes with the absorption oil vapor to the bottom of the secondary still.

From the side of the condensate still a small stream goes to the kerosine stripper for the kerosine yield, steam being used to strip it to the required flash point and distillation range.

Fractionation of Raw Product

Vapors from the accumulator for the primary still top product contain a small amount of methane, and these vapors are led to the demethanizer, after being compressed. The action of the demethanizer is described as a combination of fractionator and absorber.

It uses depropanizer bottom raw gasoline with essentially all the butanes in it as an absorption medium. A reboiler is connected to the column, and a side heater operates immediately below the feed tray. Two intercoolers are installed in the column above the feed tray.

Residue gas passes overhead, is sent through a scrubber and is recompressed and sent into the high pressure (520 psig) reabsorber column. This step is necessary since the residue gas stripped by the gasoline takes over a small portion of the reflux-absorption gasoline, and this is recovered by sending the recompressed gas through the high pressure reabsorber. Any portion of this stream, recovered finally in the primary still overhead accumulator, that may revaporize there goes again to the demethanizer in a sort of recycle system.

The demethanizer is controlled by the bottoms temperature so that a very small amount of methane remains in the bottoms, the amount being determined by the amount of methane that can be permitted in the LPG product. The stream from the demethanizer bottom goes with the primary still overhead accumulator—three streams—to

FIG. 4. Two of three banks of main oil exchangers.

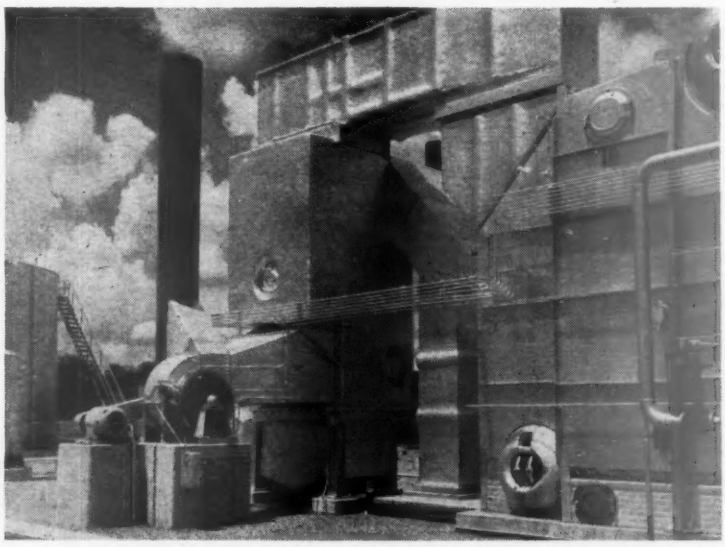
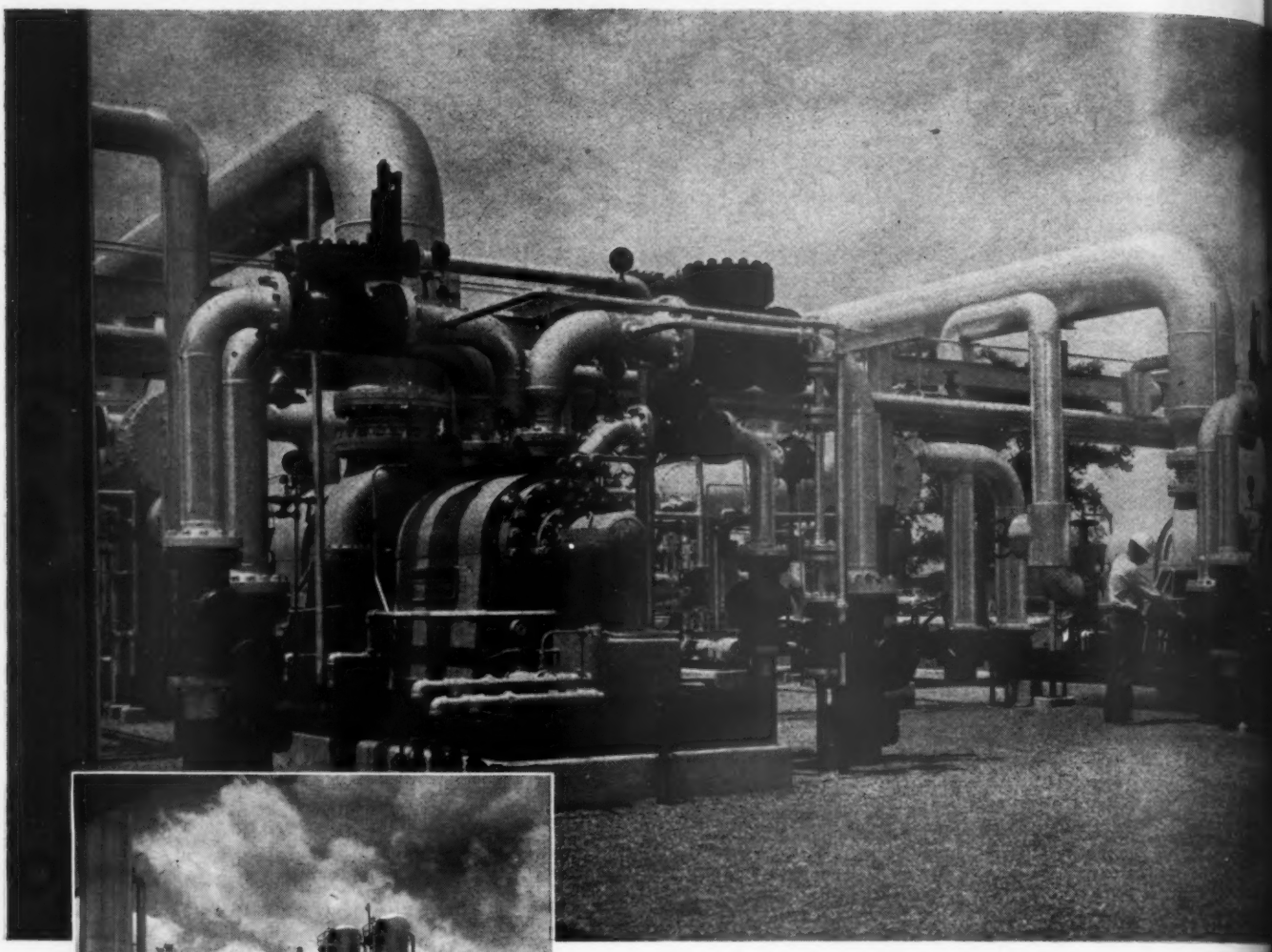
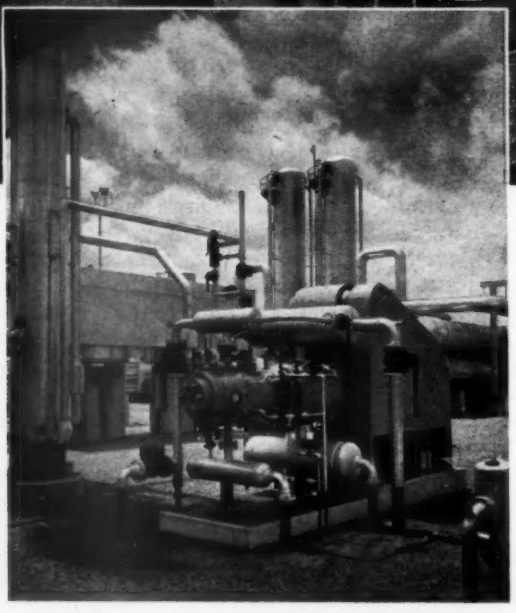


FIG. 5. Side view of (B&W) boiler showing air preheater.

XUM





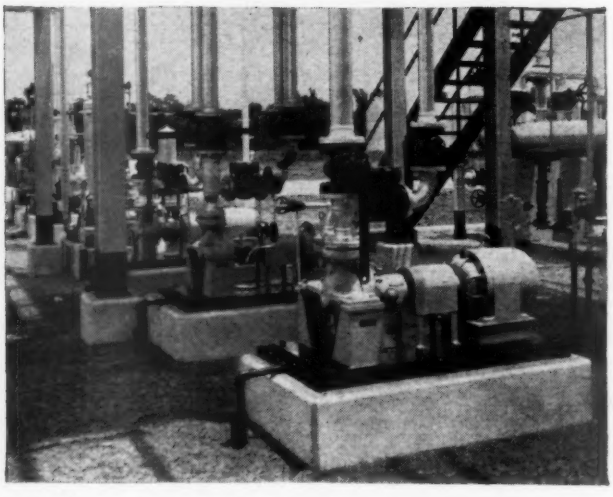
Each of these seven-stage Class CHTB I-R pumps is on lean oil service discharging to absorbers at three pressure levels: 400, 700 and 1450 PSIG. Note the neat arrangement of three sets of discharge lines.

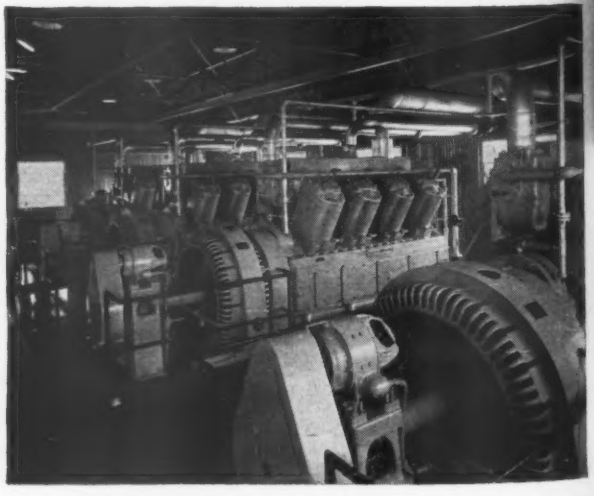
This 2-stage, motor-driven Class ES compressor handles still vapors.

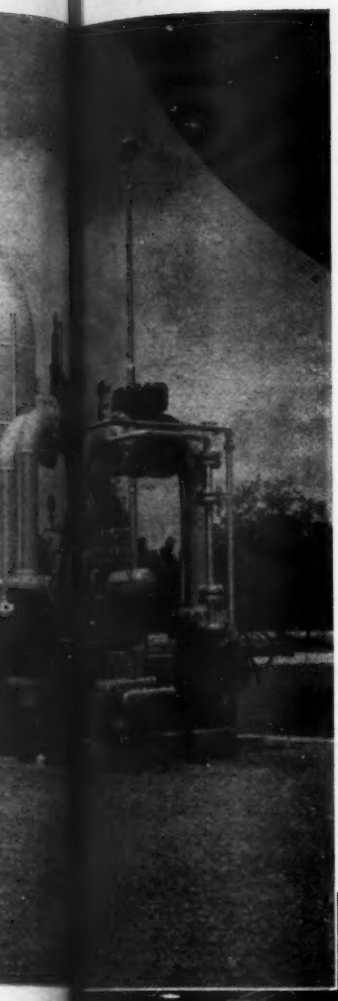
Three I-R Type SVG 6-cylinder gas engine compressors handle flash gas, to demethanizer.

Ingersoll-Rand SFLA pumps, with integral mechanical shaft seal, on reflux service.

These four PSVG8 380 kw gas engine generators supply all plant electric power.







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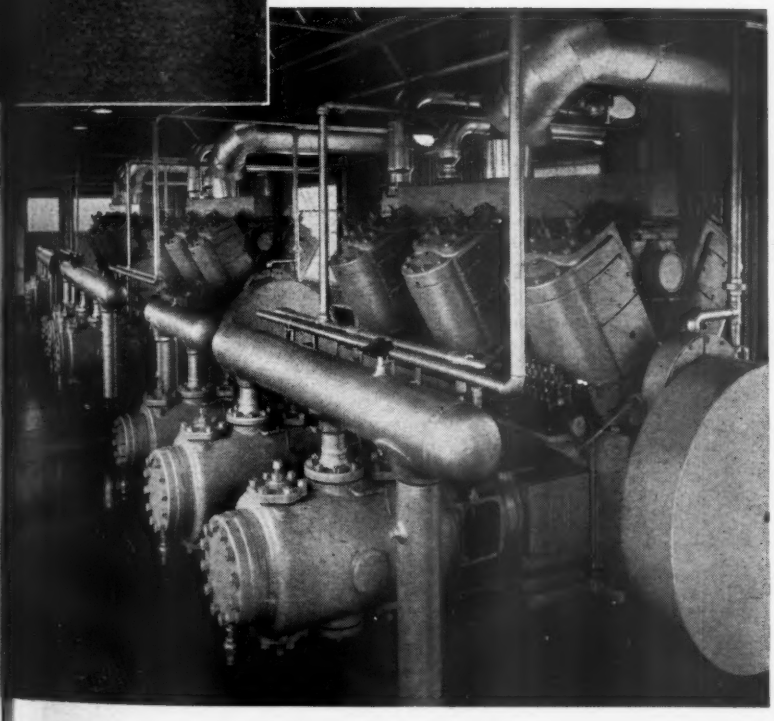

This outstanding natural gasoline plant, engineered and constructed by Stearns-Roger Manufacturing Co. processes 190 million cubic feet of natural gas per day.

Ingersoll-Rand equipment is used throughout the processing operations at Pledger. Centrifugal pumps, ranging in size from 3 hp Motorpumps to 2000 hp double-case lean oil feed units, handle the plant's liquid products in all stages of preparation. I-R compressors, in steam, electric and gas-engine-driven types, fill the plant's compressor requirements—and I-R gas engines generate 1520 kw of auxiliary power.

The new Pledger Gasoline Plant is another excellent example of how Ingersoll-Rand can meet the needs of the processing industry with equipment that is known the world over for dependability and fine workmanship. Our branch offices will be glad to help solve your pumping, compressing or power-generation problems. Their long experience is at your service.

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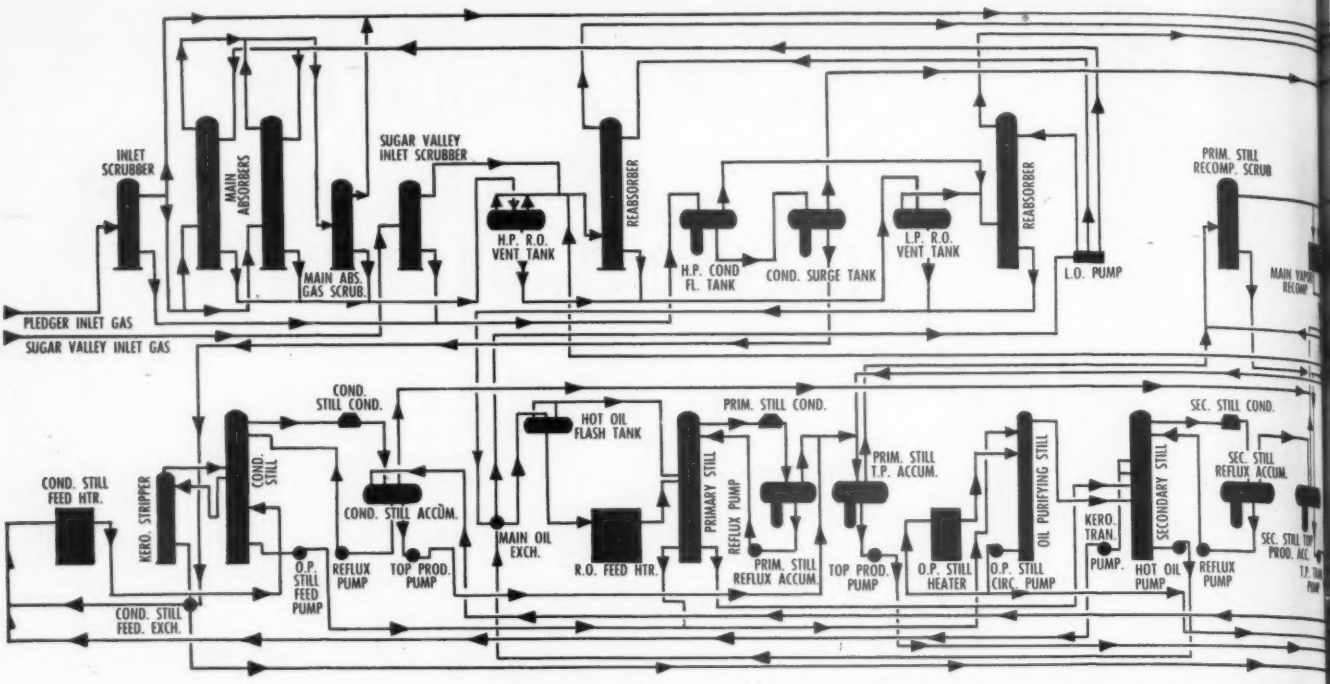


Simplified flow chart of the Pledger, Texas, plant of Southern Production Company

the depropanizer. Top product from this is an ethane-propane mixture; a regular LPG stream may be taken as a side stream if wanted, and the depropanizer bottoms, less the small absorber oil drawoff for the demethanizer, goes to the stabilizer and contains all the butanes and natural gasoline from the operation. The LPG stream may be taken from about the 35th to the 37th tray—up from the bottom—of the depropanizer.

The uncondensed vapors from the depropanizer reflux accumulator are sent to a recompressor and brought to 470-500 psig. Depropanizer accumulator overhead liquid joins the vapor product stream at its point of discharge from the recompressor and this combined stream goes to the LPG product accumulator.

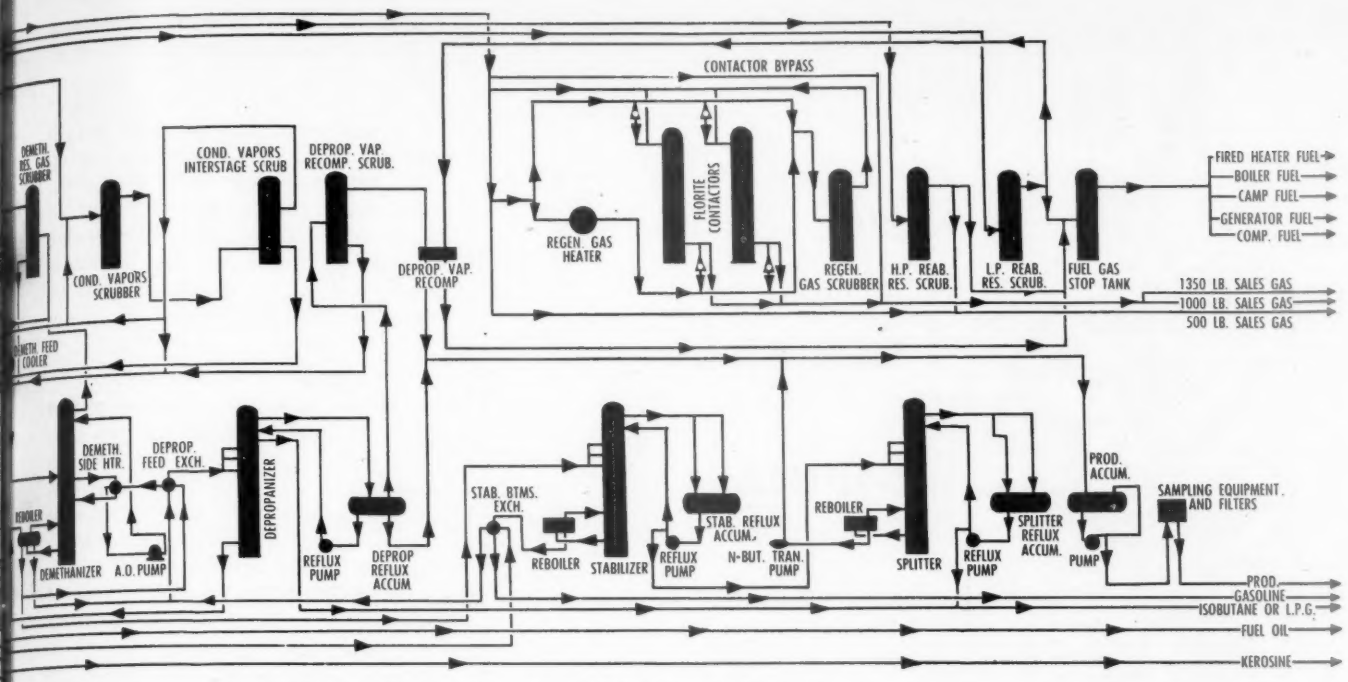
The stabilizer, to which the depropanizer bottoms is sent, makes overhead a mixed butanes stream, and the bottoms is a gasoline to such vapor pressure as the market requires at any given time. All of the overhead condensate stream is sent to the butane splitter tower to separate isobutane from normal butane. This isobutane stream off the top of the butane splitter is essentially pure isobutane, and goes directly to storage, a very premium product. The normal butane bottoms goes to the LPG accumulator, joining the depropanizer overhead stream. From this accumulator a motor-driven triplex power pump takes suction on this LPG accumulator and discharges it at 1000 psig into a pipe line for delivery through filters and then dual metering stations equipped with recording gravitometers. Continuous samples are taken "around the clock" every day by automatic equipment located just upstream from the meters.

Water Condensate System

Two systems are employed in this plant, a "clean" and a "dirty" system. Two headers are provided for the clean system, because of the difference in the temperature of the condensates. From the hot well of the surface condenser for the high pressure lean oil pump turbines one header handles only this hot well condensate, which is relatively cool, goes through heat exchangers and directly to the deaerating heater in the boiler plant. Depropanizer reboiler condensate, also condensate from the butane splitter (reboiler), and from the gas heater that regenerates the dehydration agent, all are taken via the second clean header, as a liquid but at a temperature not far below boiling and goes first to the condensate flash tank, next to the condensate skimmer tank after being cooled enroute.

The condensate skimmer tank is a vessel maintained at essentially atmospheric pressure and the dirty condensate header collects and sends into it condensate from the different still accumulators, the sales gas heater and the heater on the fuel gas line. Here the hydrocarbons remaining in the condensate are removed, either as liquid

FIG. 6. Gas-fired heaters; l. to r., OP still heater; condensate heaters; rich oil heaters (Born).



showing process routine, products made, and the various refining steps in the process.

or as vapor escaping to the atmosphere. Water from this skimmer tank then goes to the oil removal unit where more oil is removed, the condensate is filtered and goes to boiler feed-water storage and eventually into the deaerator heater. This boiler feed water tank also receives the makeup water directly from the water treating system.

Steam System

The design estimated steam demand of the plant, at about 84,000 lb per hr is supplied by 3 integral furnace type boilers, fed by 2 turbine-driven feed pumps. These boilers are equipped with both induced-draft and forced-draft fans driven by electric motors and produce 42,000 lb per hr of steam each, at 305 psig and 522 F at the superheater outlet. Steam is used normally at 300 psig in all the high pressure services such as turbines. The exhaust steam from this high pressure system is handled by two 60 psig systems, one a clean steam system and one a dirty steam system.

Water System

Two deep wells and one shallow well supply the plant's water requirements. The shallow well water goes directly to a treating unit and from this unit it is pumped into a filter and purifier and then up into the elevated water tank. Part of this water is bypassed to a zeolite softener and is then used as boiler feed makeup. This high tank supplies domestic water for the camp and all other purposes and can be used in emergency to feed the boiler, such as in the breakdown of the condensate system. Water from the deep wells is sent to raw water storage and supplies the cooling tower makeup, domestic water treater makeup, the fire system, bearing water and the backwash water for the oil removal units described above. A constant head of water on this system is assured by the installation of two pressure switches for starting and stopping the pump motors.

The plant cooling system includes a 4-cell, induced draft counter-flow cooling tower with 4 vertical cooling water pumps, along with the piping system to the exchangers, condensers and coolers. pH control on the water is maintained by a 3000-gal sulfuric acid storage tank and a small acid receiver to contain about 1 day's supply of acid. An automatic pH controller governs the acid addition rate, actuated by the pH of the treated water. A chlorine injection system combats algae growth.

Jacket water cooling is a closed system that cools the generator engines and the compressor engines also, and employs a jacket water storage tank, with two pumps, and also an aerial cooler that is operated automatically, actuated by the temperature of the out-

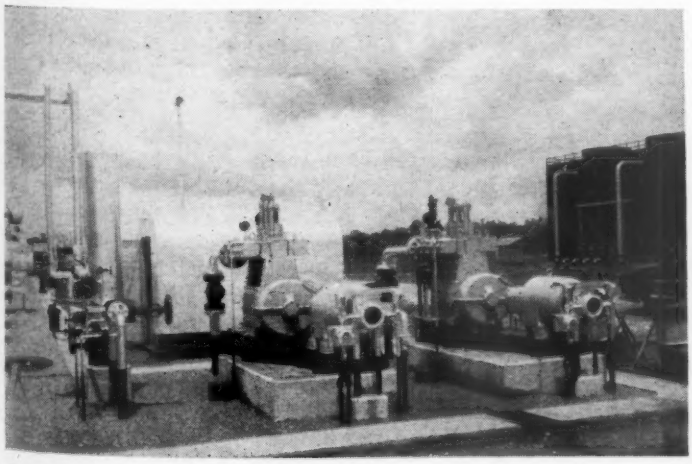


FIG. 7. LPG pipe line pumps.

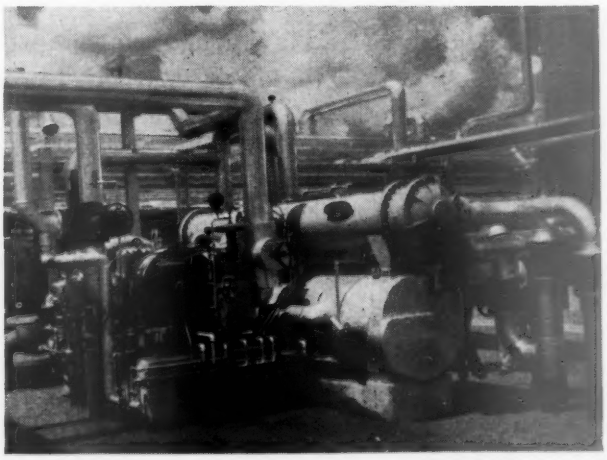
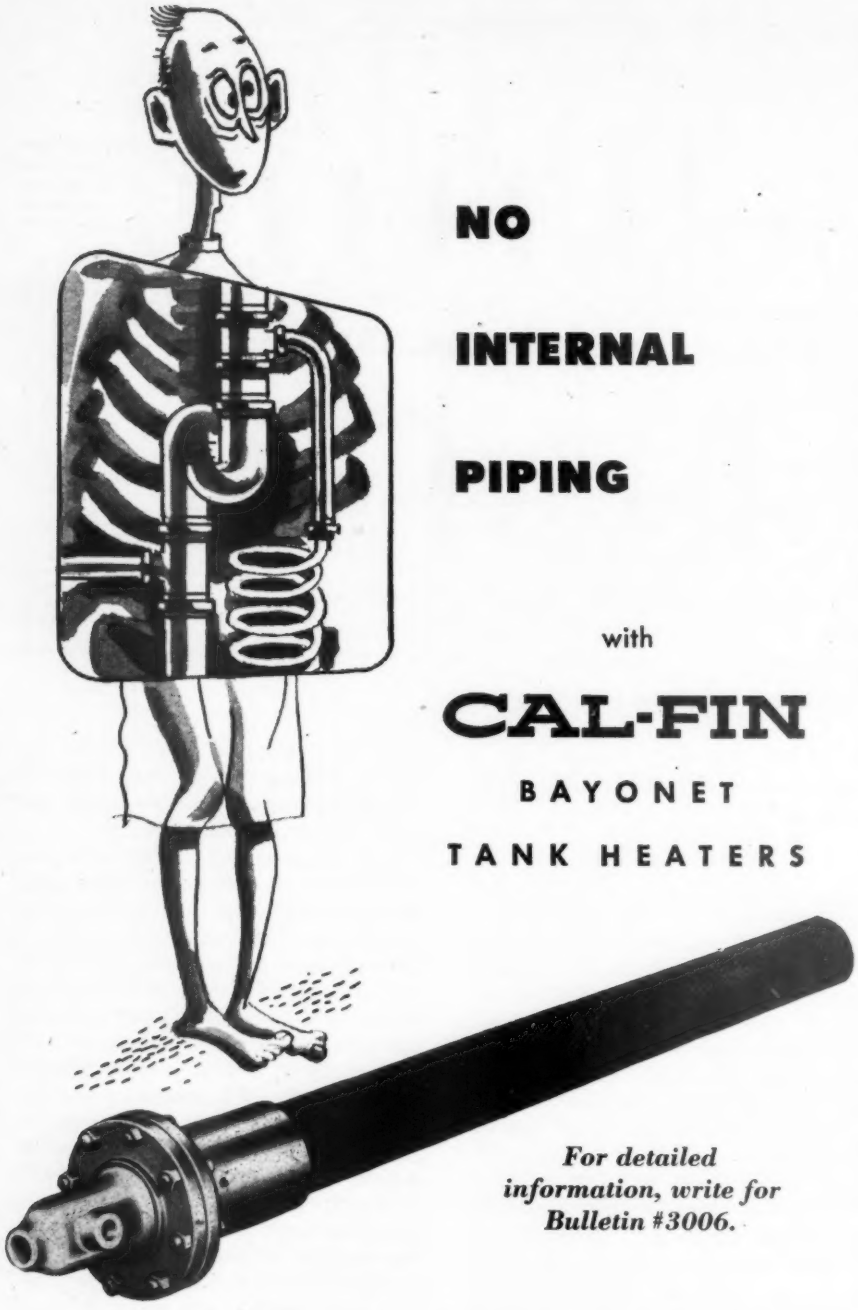


FIG. 8. Refrigeration unit for demethanizer (Carrier).



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going water. The refrigeration water is also in a closed system, having a small chilled water surge tank and two pumps. Water is chilled in the refrigeration unit evaporator, pumped through the demethanizer feed chiller, the top and bottom intercoolers of the demethanizer and returns to the chilled water surge tank. The refrigeration system is powered by a turbine that is controlled automatically, actuated by the cold water temperature.

Plant Fuel System

The low pressure reabsorber residue gas and such quantities of high pressure reabsorber gas as is needed for makeup is the plant fuel gas supply. On its way to the fuel gas stop tank the low pressure reabsorber residue is expanded in the depropanizer vapor recompressor from 295 to 50 psig, to power that unit, any excess of gas for this operation bypassing the recompressor direct to the storage or stop tank through a pressure reducer regulator. The fuel gas goes to the fuel header from the direct-fired heaters, reduced to 30 psig; then to boiler fuel gas header and is reduced to 25 psig; finally the remainder to the recompressor fuel gas header, and the generator fuel gas header, reduced to 1 psig. A portion of this stream is reduced to 20 psig, goes through an odorizer and positive displacement meter and is consumed in heating offices and the employee camp.

Plant Air System

Two main parts of the air system are the instrument air and the starting and utility air systems. Two compressors with aftercoolers send air into a receiver at 50-60 psig which supplies air at this pressure range to all instruments except the combustion controls; these use air at 40 and at 28 psig. Starting air is supplied by 2 compressors, 1 electric motor driven and 1 gas-gasoline engine driven, pumping air into the receivers at 250 psig, which is used to start the generators and the main recompressors. From these receivers also 100 psig air is led off as general utility air, and as emergency instrument air makeup, at about 40 psig.

Emergency Shutdown Systems

Three separate systems cover the plant's emergency shutdown needs. In each of them pressure must go off to shut down the plant. Ordinarily the operating medium is 1800 psig gas from the inlet stream and this is reduced in two stages to 175 psig, and finally to 40 psig before it goes to the 3 emergency systems. To shut off the inlet gas lines, gas at the 175 psig stage is employed, piston-operated shutoff valves being installed on these lines. * * *

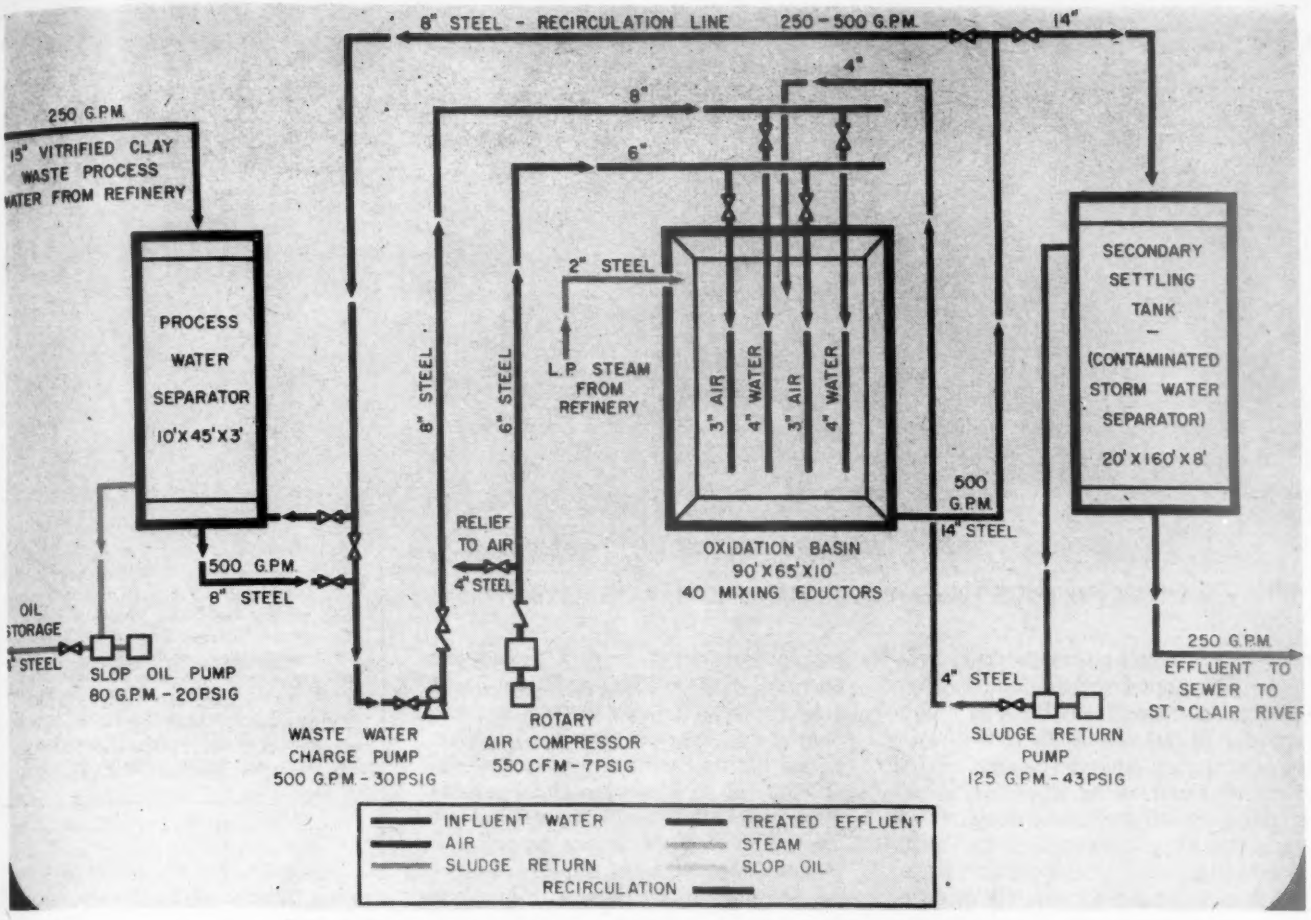

FIG. 1. Flow diagram of waste handling system, Sun Oil's Sarnia refinery.

In Ontario, the pollution problem resulting from refinery operation solved by

*Bio-oxidation of Plant Wastes**

A. V. DE LAPORTE

EARLY in October 1953, prior to the initial processing operations at its Sarnia refinery, the Sun Oil Company Ltd., developed plans and initiated construction of facilities for the biological oxidation of phenolic compounds in the refinery wastes. The speed of design and construction of these facilities was made possible by investigations made of this problem by other companies. Results of these studies were made available to the Sun Oil Company.

The Dow Chemical Company of Midland, Michigan, has studied the bio-oxidation of phenols for many years. The Imperial Oil Company, Ltd., had recently completed a study of the Dow processes as applied to oil refinery wastes. Throughout the period of design, construction, and initial operation the knowledge of bio-oxidation obtained by these companies was supplied by A. D. McRae of the Imperial Oil Company and T. J. Powers of the Dow Chemical Company. This cooperation enabled the Sun Oil Company to establish something like a record in the speed of design, construction, and placing in operation of a full-scale dephenolization unit.

In the original design of the refinery sewer system the engineers of the Sun Oil Company anticipated certain waste waters containing oxygen-consuming pollutants would require secondary treatment following primary gravity separation of oil. All drainage in the refinery was segregated into cooling water, contaminated storm drainage, uncontaminated storm draining, sanitary sewage, and process sewer systems. The total of these effluent streams averages 14,000,000 gal per day. Over 90 per cent of the phenols, sulfides, mercaptans, and other water soluble contaminants are found in the process sewer system that collects process condensate waters from vessels and towers, pump gland leakage, and desalting waste water.

As shown on the flow diagram

*Part of a paper given before Purdue University Industrial Waste Conference, May, 1954.

FIG. 2. View of the separator and biological treatment area from the refinery process area.

(Fig. 1) this process waste flow, averaging 250 gpm or approximately 350,000 gal per day, flows through a concrete API single-section gravity-type separator, for removal of free oil. At the outlet end of the separator, a self-priming centrifugal pump rated at 500 gpm at 35 psig transfers the waste water to an earth-wall oxidation basin, 90 ft long, 65 ft wide, and 10 ft deep. The water enters the bottom of the basin through a next of 40 Penberthy mixing eductors.

A rotary compressor, rated at 500 cfm at 7 psig, supplies air to the eductors to supply oxygen and provide intimate mixing. The overflow from the aeration basin is through a peripheral slit-pipe flume to a large concrete API gravity separator originally designed for oil-removal service. This separator is equipped with continuous flight scrapers and serves as a secondary settling tank for bacterial sludge. A positive displacement type, 125 gpm, 43 psig, sludge pumps returns the settled bacterial floc to the oxidation basin and the treated water flows from the secondary separator to the St. Clair River. Piping has been provided to recirculate all or a portion of the oxidation basin effluent during periods of low volume feed and when the refinery is shut down. Views of the process separator and the oxidation basin are shown in Figs. 2 to 6.

These modified activated sludge facilities were placed in operation at the middle of November, 1953, in time to treat the first waste waters from the refinery. Two tank truck loads of bacterial sludge from the Dow Chemical Company waste treatment plant at Midland, Michigan, were obtained for initial seeding. The approximate cost of the new facilities was $25,000. This does not include the value of previously installed equipment including the process separator, secondary settling tank, the sludge return pump and the process water collecting system.

Experience through the first 5 months of operation indicates an initial phenol content in the process waste feed of 100-150 lb per day. Numerous start-up and mechanical difficulties as well as climatic conditions, as described below, have interfered with efficient performance, yet over 95 per cent removal of phenol and 100 per cent removal of sulfide has been effected when operating conditions are normal and equipment is performing properly. Efficient operating conditions include a bacterial sludge volume index of 3-4 per cent, a temperature range of 65-80 F, and a pH range of 7.0-8.5.

The Author

A. V. DeLaporte is chemical engineer in charge of the experimental station of the Sanitary Engineering Division, Department of Health, Ontario, Canada. He holds the BS Sc. degree in chemical engineering, is chemical engineer F. C. I. C., and a registered chemical engineer in Ontario. His responsibilities extend apparently completely across the Sanitary Engineering and Department of Health fields in Ontario as he is a member of the Pollution Control Board of Ontario; member of Canadian Advisory Board to the International Joint Commission and in charge of pollution work for the Canadian Section of that Commission. DeLaporte is also a member of the Industrial Waste Commission of the Research Council of Ontario. His investigations of the important field discussed in this article are authoritative in the last degree, in showing what has been accomplished in the bio-oxidation of refinery wastes to permit proper disposal of such waste materials.

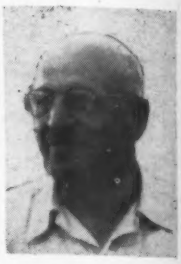

FIG. 3. View of the oxidation basin during construction.

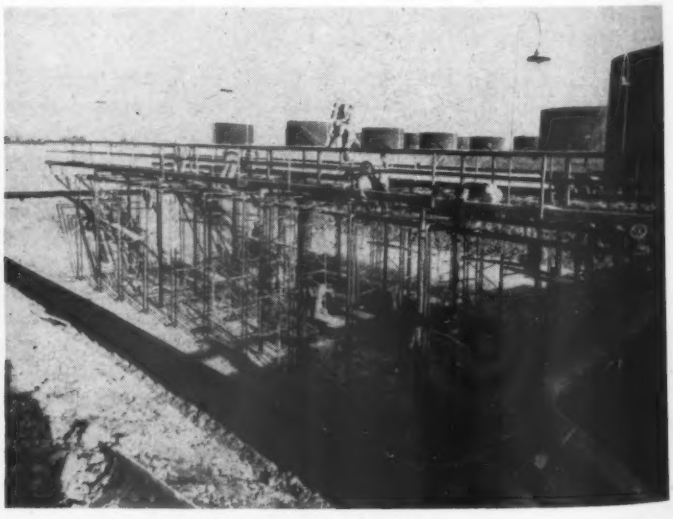

FIG. 4. Close-up of oxidation basin during construction.

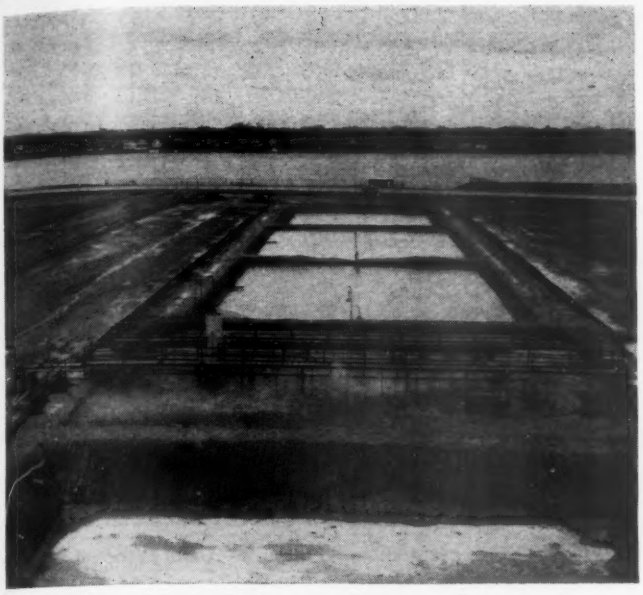

FIG. 5. View of basin during operations on refinery wastes.

FIG. 6. Close-up of oxidation basin during operation.

Experience indicates that the process will operate with a temperature as low at 60 F. Dissolved and emulsified oil concentrations as high as 150-200 ppm, phenol concentrations up to 200 ppm, and sulfide concentrations as high as 250 ppm have had no pronounced harmful effect on the biological activity. In the case of all such factors, it is important to avoid sudden or "shock" loadings whenever possible.

It has been noted that the organisms can remain inactive for several days, under adverse conditions, and then regain their former activity with the return of normal temperature and food supply. Each jet aerator or eductor in the oxidation basin supplies 50 lb of oxygen or a total of 2000 lb of oxygen per day from the air into the waste water to oxidize the 100-150 lb of phenol, considerably in excess of the theoretical required amount. The aeration tank loading is equivalent to 5 lb of phenol per 1000 cu ft of tank volume, and the applied air rate is equivalent to 0.1 cu ft per minute per square foot of aeration surface. Total power requirements amount to approximately 60 hp.

Among the difficulties encountered in operation, low temperature below the 55 F minimum has been the most troublesome. Steam, when available from the refinery is introduced through 1-in. steel pipe coils with submerged exhausts into the oxidation basin. Recently, a direct-contact 2,500,000 Btu per hour water heater has been installed.

High oil content in the feed, although apparently not toxic to the organisms and is actually partially oxidized, is adsorbed on the biological floc and floats the latter to the surface of the basin thereby removing organisms from the process. Change in feed water characteristics, including variations in pH and type and concentration of phenolic content, interferes with the acclimatization of the bacteria to the waste water.

The secondary settling tank was originally designed as an oil-water separator and is over-sized and not of conventional design for biological sludge recovery. Mechanical difficulties with the pumps during initial operating and the usual start-up problems associated with a new refinery presented difficult operating conditions. There have been periods, for example, when the refinery units were not operating, and there was no continuous flow of waste process water. During such periods, it was necessary to recirculate water in the biological treatment unit and chemical-grade phenol was used to continue the food supply.

Additional experience, warmer weather, and continuous normal operation of the refinery are permitting more effective operation of the biological treatment facilities. It is anticipated that additional equipment will be installed to maintain continuity of operation.

A check on the efficiency of dephenolization was made by a field party of the Canadian Section of the International Joint Commission in late January 1954. The phenol removal at the time of the tests was better than 95 per cent. The average daily phenol discharged to the river was 5 lb. Gordon Henderson, manager of the Sarnia refinery of the Sun Oil Company and the company management can well be congratulated on this contribution to pollution abatement in general and the international waters in particular. It is hoped that when sufficient operating data has been accumulated, Henderson can be persuaded to give a paper that will give a complete picture of the details of design and operation of this unit.

The details of the treatment plant, dimensions, equipment, operation, etc., were made available by H. F. Elkin of the engineering division of the manufacturing department of the Sun Oil Company. I want to thank the officials of the Sun Oil Company and Elkin in particular for their co-operation in making this material available.

* * *

Shell's Iso-pentane Plant, Britain's First

Britain's first iso-pentane plant is under construction at Shell's Stanlow Refinery, Cheshire, England. Scheduled for completion in 1955, it will have a column, 200 ft high, believed to be the tallest of its kind in the world.

Expected to cost $1,400,000, the new plant will have an output of 5,000,000 tons annually.

At this new plant debutanized light platformate will be led through a steam preheater to the depentanizer where the pentanes will be removed as a top product. The bottom stream, depentanized light platformate, will be run down to aviation component storage.

The de-iso-pentanizer, a 200-ft column, will contain 140 Turbo-grid trays and will receive 2 streams via steam heaters, the pentane fraction produced above and debutanized straight run gasoline, and produce iso-pentane as the overhead stream. The bottom product consisting of de-iso-pentanized straight run gasoline plus the normal pentanes from the platformate will be blended into motor fuel.

C. M. J.

XUM

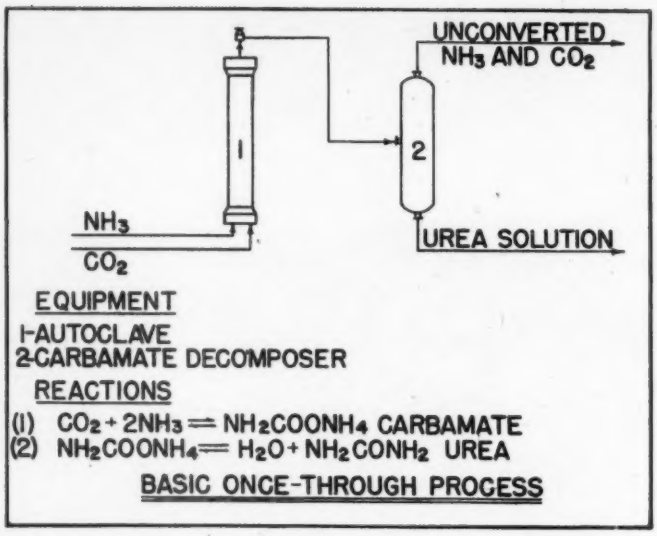

FIG. 1. Once-through process has double reaction in autoclave followed by dissociation of unconverted raw materials.

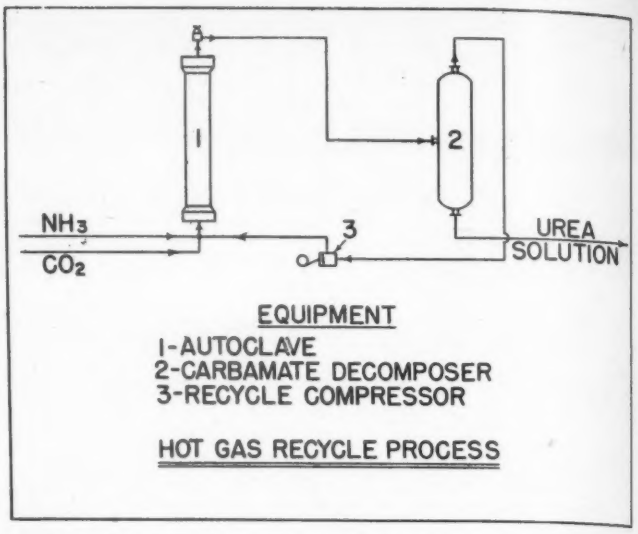

FIG. 2. Unconverted gases recompressed and returned to autoclave under high temperature.

New Carbamate-to-Urea Process Disclosed

Simple recovery and recycling methods featured; 76% of raw materials converted to desired product

EUGENE B. BRIEN*

A NEW carbamate-to-urea process was revealed to the industry at the March meeting of the American Institute of Chemical Engineers, Washington, District of Columbia, in one of the symposium papers on chemical engineering in the fertilizer industry. Principal uses of urea are as a fertilizer high in nitrogen content and as a raw material for plastics.

Principal features and advantages of the process — developed by Chemical Construction Corporation — were said to be an efficient conversion of raw material into urea — 76 per cent compared to 40-70 per cent for other processes — and simple recovery of excess raw materials and excess unconverted ammonia.

Presented by L. H. Cook, Chemical Construction Corporation, the paper outlined the chief points of four other common urea processes, each distinguished from the other chiefly by a different method of recovering and recycling the two raw materials.

All commercial processes are variations of the basic, once-through method in which the gases not converted in the first pass are removed from the system (Fig. 1).

Basic Process

Ammonia and carbon dioxide are fed to the urea autoclave (1) in a 2-to-1 mole ratio and undergo the following reactions:

$$CO_2 + 2NH_3 = NH_2COONH_4$$
(ammonium carbamate)

The carbamate is then dehydrated in the same vessel to urea:

$$NH_2COONH_4 = H_2O + NH_2CONH_2 \text{ (urea)}$$

The first reaction is highly exothermic; its excess heat is normally removed through a heat transfer surface in the autoclave. The reaction product (urea, water, unconverted carbamate) leaves the autoclave for the carbamate decomposer (2) in which the carbamate is dissociated into ammonia and carbon dioxide. These unconverted gases are usually sent to a byproduct fertilizer plant wherein the ammonia is recovered as ammonium sulfate and the carbon dioxide is vented. As neither of the unconverted gases is returned to the autoclave, the process is called the once-through process.

The urea soultion remaining in the decomposer after the gases are recovered is first concentrated, crystallized, dried, cooled, and bagged.

The process is currently followed in Germany by I. G. Farben, in England by I. C. I. and until recently, when it changed to the recycle process, it was followed in the United States by Allied Chemical and Dye Corporation.

Chemico Process

In the latest process (Fig. 6), a 6-to-1 ratio of liquid ammonia and carbon dioxide is fed to the urea autoclave (1). Use of 200 per cent excess ammonia and certain features in the plant permit a theoretical carbamate-to-urea conversion of 83 per cent. Conditions in the autoclave are such that a heat transfer surface is not required.

Effluent from the autoclave flows to the excess ammonia separator (2) where distillation removes 98 per cent

*Eastern Editor.

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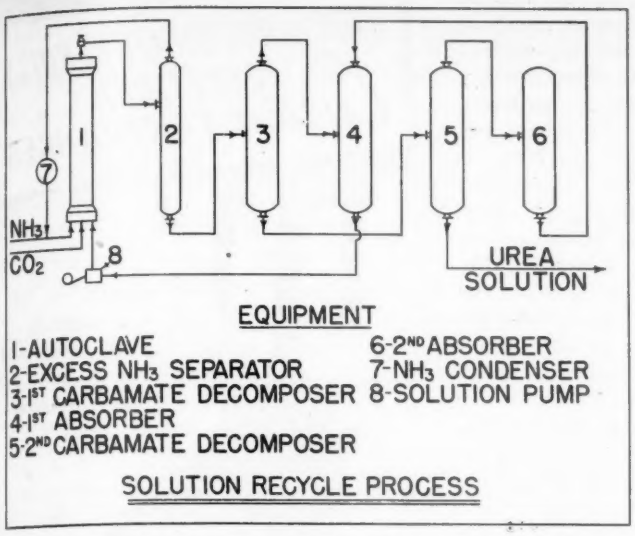

FIG. 3. Ammoniacal aqueous solution of ammonium carbamate returns unconverted gases to reaction vessel.

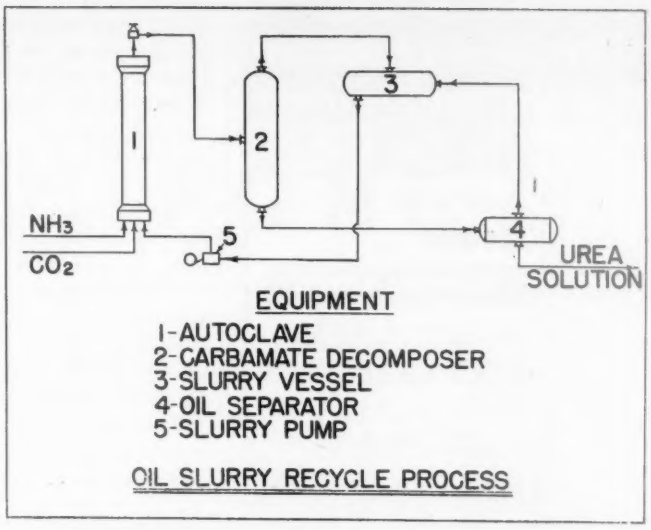

FIG. 4. Inert oil slurry, recycled to urea autoclave, acts as carrier of heat and ammonium carbamate.

of the excess ammonia. Removed overhead, this gas is sufficiently dry and free of carbon dioxide to be condensed with water and returned immediately to storage for re-use.

Bottoms from the separator flow under low pressure to the carbamate decomposer (3) where the remaining ammonia and carbon dioxide, unconverted in the first pass, are removed and sent to the CO_2 absorber (4). Carbon dioxide is absorbed from the mixture with a solvent, thus freeing the ammonia for compression and return to storage.

The solvent-containing CO_2 is removed and vented, or recycled.

The aqueous solution of urea that leaves the carbamate decomposer (3) as bottoms is concentrated in an evaporator and finished in the normal way.

Several notable advantages are claimed for this process, compared to other processes with lower conversion ratios.

The carbon dioxide to be compressed, purified, condensed, and recirculated is almost halved, the heat transfer surface in the autoclave is eliminated and the amount of ammonium carbamate to be handled is reduced by ⅘.

Total costs for a Chemico urea plant capable of bagging 150 tons urea per day are placed at around $3,250,000, although actual costs can vary up and down from that sum depending upon plans.

Hot Gas Recycle Process

This process was first reported by the Fiat papers. It is characterized by the separation in the carbamate decomposer of unconverted gases and by their recompression for recycle to the autoclave, as is shown in Fig. 2.

Solution Recycle Process

The solution recycle process returns unconverted gases as an ammoniacal aqueous solution to the autoclave where they are joined with fresh ammonia and carbon dioxide (Fig. 3). The process uses 150 per cent excess ammonia and achieves a carbamate to urea conversion of about 70 per cent.

The autoclave (1) overhead flows to the excess ammonia separator (2). Eighty-four per cent of the excess ammonia is separated overhead, condensed, and sent to storage. The remaining bottoms flow to the first carbamate decomposer (3) in which a fairly dry ammonia-carbon dioxide stream is removed overhead, and passes to the primary absorber. The mix-

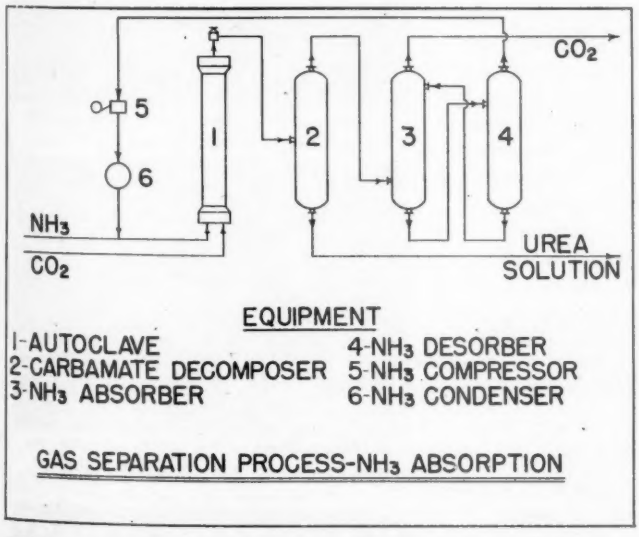

FIG. 5. Ammonia is absorbed in urea nitrate solution, desorbed, compressed, liquefied and recycled to autoclave.

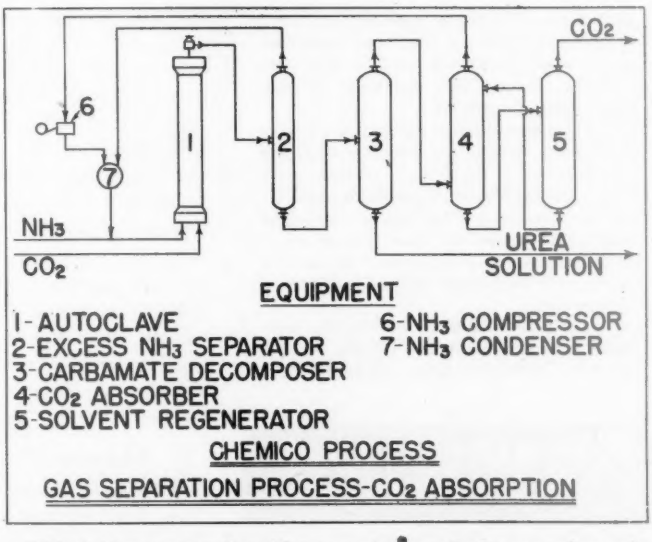

FIG. 6. New process has 83 per cent theoretical conversion rate, lower capital equipment per ton of urea.

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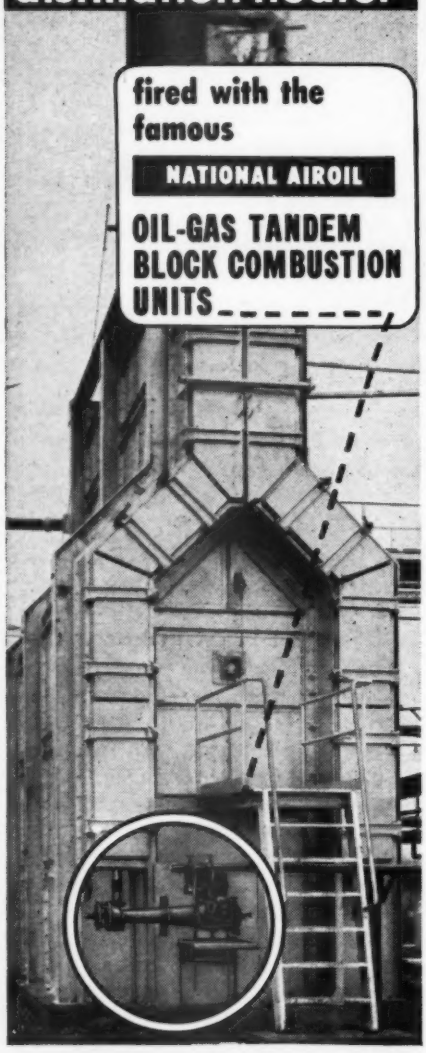

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ture of urea, water, ammonia, and undissociated carbamate removed from the bottom of the decomposer enters a second decomposer (5) where free ammonia, water vapor and the remaining carbamate are driven off overhead and into the second absorber (6). Water in this stream is condensed and the ammonia and carbon dioxide reabsorbed, leaving an ammoniacal aqueous solution of ammonium carbamate. Returned to the primary absorber (4), the aqueous solution contacts overhead gas from the primary decomposer; the resulting solution is returned to the autoclave for another pass.

The solution removed as bottoms from the second decomposer is urea; it is finished in the regular manner.

Oil Slurry Recycle Process

In the oil slurry recycle process, a suspension of carbamate in oil is fed to the autoclave (1) along with a 2-to-1 ratio of ammonia and carbon dioxide (Fig. 4).

Effluent from the reaction vessel is sent to the carbamate decomposer (2) where the unconverted carbamate is dissociated into an ammonia-carbon dioxide gas mixture. The mixture is removed overhead and comes in contact with oil in the slurry vessel (3) in which fine ammonium carbamate particles form and remain in suspension. This oil slurry is recycled to the autoclave.

Bottoms from the decomposer containing urea, water and oil, flow to the oil separator (4) where the oil is separated by decantation and returned to the slurry vessel, and the bottoms, an aqueous solution of urea, are finished in the usual manner.

Gas Separation Recycle Process

In the gas separation process (Fig. 5), a slight amount of excess ammonia is fed to the autoclave (1). Effluent from the reaction vessel enters the carbamate decomposer (2) where the carbamate is dissociated into ammonia and carbon dioxide. The remaining urea solution is removed as bottoms and finished. The overhead gas mixture flows to the ammonia absorber (3) where the ammonia is absorbed in an aqueous urea nitrate solution, thus liberating carbon dioxide that may be vented or recycled. The urea nitrate solution is pumped to the ammonia desorber in which the ammonia is removed. It is then compressed, liquified and returned to process. The desorber solution is returned to the absorber for re-use.

Chemico Plant in Japan

Features of the Chemico process have been in commercial operation at the large urea plant of Sumitomo Chemical Company in Japan. * * *

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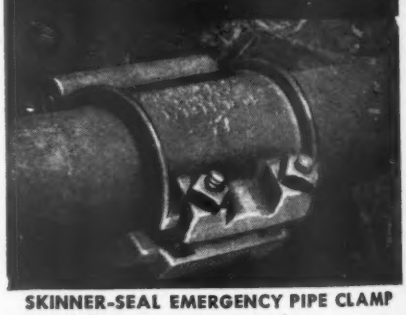

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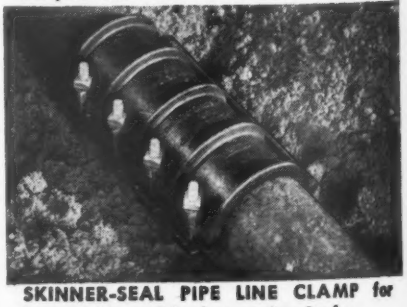

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Q What are the essential raw materials, intermediates, and steps in the synthesis of the following (trade-named) products: Dacron, Nylon, Saran fibers? We are interested especially in the part that petroleum and natural gas hydrocarbons play in producing these materials.
N. M. C.

A The following answer gives merely the basic chemistry involved in the formation of the polymers used in these synthetic fibers. No attempt is made to discuss the very important steps of the physical treatment of the polymer in its conversion to synthetic fiber. Nor is the manufacture of acetylene, benzene, butadiene, and ethylene from petroleum discussed here as the literature on these operations is extensive and accessible. The manufacture of ammonia from natural gas is an equally well known development. The co-oxidation of ammonia and methane to hydrogen cyanide, HCN, is an established operation; the HCN made is neutralized with caustic alkali to give sodium cyanide. Chlorine is obtained by the electrolysis of sodium chloride which also yields hydrogen. Hydrogen and chlorine are burned to hydrogen chloride. If cell hydrogen is not available hydrogen from the reforming of natural gas or propane can be used instead. Thus all of the raw materials except chlorine can be obtained from petroleum or natural gas hydrocarbons.

Dacron—Dacron is a polyester fiber developed by Imperial Chemical Industries, Ltd., of Great Britain and introduced in this country by DuPont. The Dacron raw materials are ethylene glycol and terphthalic acid. The overall basic chemical reaction for the formation of the polyester is given by equation (1) below:

$$n\,C_2H_4(OH)_2 + n\,HOOC{\bullet}C_6H_4{\bullet}COOH = HOC_2H_4O\left[OC{\bullet}C_6H_4{\bullet}COOC_2H_4O\right]_{n\text{-}1}OC{\bullet}C_6H_4COOH + n\,H_2O \quad (1)$$

(Ethylene glycol + Terphthalic acid = Polyester + Water)

Ethylene glycol is made from ethylene separated from refinery gas or prepared by the cracking of light paraffins, chiefly ethane or propane. Terphthalic acid is made by oxidation of paraxylene recovered by fractional crystallization from either petroleum or coal tar mixed xylene isomers. The petroleum xylenes are now available in quantity in product streams from catalytic hydro forming operations.

Nylon—Nylon is the polyamide fiber developed by DuPont. The polymer is made by the reaction of adipic acid with hexamethylene diamine which is given simply by the following overall reaction:

$$n\,HOOC\,C_4H_8COOH + n\,H_2NC_6H_{12}NH_2 = H_2NC_6H_{12}NH\left[OC{\bullet}C_4H_8COHN_6H_{12}NH\right]_{n\text{-}1}OCC_6H_{12}COOH + n\,H_2O \quad (2)$$

(Adipic acid + Hexamethylene Diamine = Polyamide + Water)

Adipic acid is made from cyclohexane separated from natural fractions or made by the hydrogenation of benzene from petroleum or coke oven sources. The cyclohexane is oxidized with atmospheric oxygen. The reactions are

$$C_6H_{12} + 2.5\,O_2 = HOOC\,C_4H_8COOH + H_2O \quad (3)$$

(Cyclohexane; Adipic acid + Water)

or

$$C_6H_{12} + \tfrac{1}{2}\,O_2 = C_6H_{11}OH \quad (4)$$

(Cyclohexanol)

$$C_6H_{11}OH + \tfrac{1}{2}\,O_2 = C_6H_{10}O + H_2O \quad (5)$$

(Cyclohexanone)

$$C_6H_{10}O + 3/2\,O_2 = HOOC\,C_4H_8COOH \quad (6)$$

(Adipic acid)

Hexamethylene diamine can be made from the adipic acid so obtained by the following reactions:

$$2NH_3 + HOOC\,C_4H_8COOH = H_2NOCC_4H_8CONH_2 + 2H_2O \quad (7)$$

(Ammonia + Adipic acid = Adipamide + Water)

$$H_2NOCC_4H_8CONH_2 = NCC_4H_8CN + 2H_2O \quad (8)$$

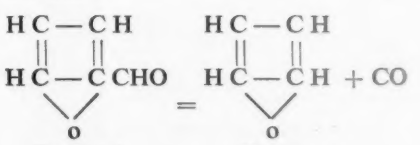
(Adipamide = Adiponitrile + Water)

$$NCC_4H_8CN + 4H_2 = H_2N{\bullet}C_6H_{12}{\bullet}NH_2 \quad (9)$$

(Adiponitrile = Hexamethylene diamine)

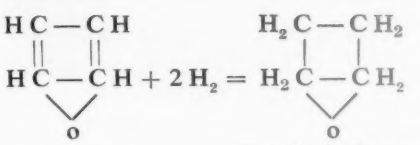
Cheaper methods for the diamine are based on converting furfural or petroleum butadiene to adiponitrile which in turn is reduced to the diamine. Furfural is converted to adiponitrile in an over-all yield of about 75 per cent by the following reactions:

Catalytic decarbonylation of furfural to furan



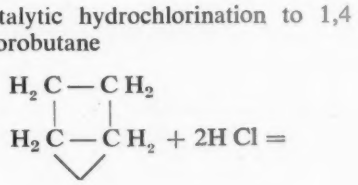
Furfural = Furan (10)

Catalytic hydrogenation to tetrahydrofuran



Tetrahydrofuran (11)

Catalytic hydrochlorination to 1,4 dichlorobutane



$$Cl\,C_4H_8Cl + H_2O \quad (12)$$

(Dichlorobutane)

Conversion to adiponitrile in solution

$$2\,NaCN + ClC_4H_8Cl =$$

(Sodium Cyanide)

$NCC_4H_8CN + 2\,NaCl$
Adiponitrile . . . . . (13

When using butadiene the first step is hydrochlorination to dichlorobutane

C_4H_6 (1,3 Butadiene) + $2HCl$ (Hydrogen Chloride) = $C_4H_8Cl_2$ (Dichlorobutane) . . . . . (14)

This is then reacted with sodium cyanide to give adiponitrile

$$C_4H_8Cl_2 + 2NaCN = NCC_4H_8CN + 2NaCl \quad . \; . \; (15$$

Saran—Saran is made by Dow Chemical Company. The term Saran applies to a series of vinylidene chloride polymers and copolymers. Saran fiber is made under Dow patents from a copolymer of vinylidene chloride with vinyl chloride. The copolymer is dominantly on the vinylidene side in composition. The vinyl chloride is added to decrease the resin softening point and increase the resin flexibility. The basic raw materials are ethylene or acetylene and hydrogen chloride and chlorine.

Vinyl chloride can be prepared in two ways. Acetylene reacts directly with hydrogen chloride to give vinyl chloride.

$$C_2H_2 + HCl = CH_2CHCl \quad \text{(Vinyl chloride)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (16)$$

Alternately ethylene can be chlorinated and dehydrochlorinated as shown to give vinyl chloride.

$$C_2H_4 + Cl_2 = C_2H_4Cl_2 \quad \text{(Dichloroethane)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (17)$$

$$C_2H_4Cl_2 = CH_2CHCl + HCl \quad \text{(Vinyl chloride)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (18)$$

Vinylidene chloride may likewise be made in two ways. The first is the addition of chlorine to acetylene in the presence of a catalyst such as ferric chloride.

$$C_2H_2 + Cl_2 = CH_2CCl_2 \quad \text{(Vinylidene chloride)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (19)$$

The other method is based on ethylene which is chlorinated under controlled conditions to 1,1,2 trichloroethane. On heating with an alkali, hydrogen chloride is split off yielding a mixture of dichloroethylene isomers from which vinylidene chloride can be separated by distillation.

$$C_2H_4 + Cl_2 = C_2H_3Cl_3 + HCl \quad \text{(Trichloroethane)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (20)$$

$$C_2H_3Cl_3 = CH_2CCl_2 + HCl \quad \text{(Vinylidene chloride)} \quad . \; . \; . \; . \; . \; . \; . \; . \; . \; . \; (21)$$

To make Saran, vinyl chloride and vinylidene chloride are copolymerized in water emulsion with a peroxide catalyst. The resulting resin is converted to fiber. *James H. Boyd.*

Perchlorato-ceric Acid,

Q **Will you please give us the details of the reagent, perchlorato-ceric acid, mentioned in your article published in *Petroleum Engineer*, June, 1952, page C-48?** *D. M. L.*

A The reagent used in this test is reagent grade 0.5 M perchlorato-ceric acid in 6 M perchloric acid and is manufactured by the G. Frederick Smith Chemical Company, 867 McKinley Avenue, Columbus, Ohio. This reagent is obtainable directly from the manufacturer and also a number of laboratory supply companies. If an order is made through a laboratory supply company it might be wise to specify the manufacturer as they are one of the few manufacturers of rare earth elements of reagent quality.

C. D. Greene.

Additives for Lubricating Oils

Q **What is the chemical nature of the various classes of additives employed to enhance the properties of lubricating oils, for (1) oiliness or film strength; (2) detergency; (3) viscosity index improvement; (4) low temperature fluidity; (4) carbon deposition resistance?** *K. M. L.*

A **Oiliness Agents.** Fats, fatty acid esters, and soaps, all having in common a molecule containing a long hydrocarbon chain and a more active or polar portion, have been used to improve friction reducing properties of oils. Under extreme conditions of pressure, other additives are used to prevent the welding of metal surfaces. These latter substances usually contain sulfur, phosphorus, and/or chlorine in compounds such as sulfurized fats, phosphite esters, and chlorinated waxes.

Detergents. The more commonly used detergents are the barium or calcium salts of sulfonic acids. These oil soluble sulfonic soaps act principally as dispersants to keep combustion products suspended in the oil instead of settling out and depositing on engine parts.

Viscosity Index Improvement. Viscosity index improvers are polymerized substances of extremely large molecular dimensions. The more commonly used are polymerized butylene and methacrylate polymers. These long chain molecules create internal friction within the oil, thus raising its viscosity. As the relative increase in viscosity is greater at elevated temperatures, the viscosity index is improved.

Low Temperature Fluidity. Some of the methacrylate polymers are effective pour depressants, as are also wax/phenolate and wax/naphthalene condensates. These materials operate by retarding the formation of wax crystals or modifying their lattice-like structure which would otherwise interfere with the flow of the oil.

Carbon Deposition Resistance. The deposition of carbon is retarded by two means. First, by the use of detergents as mentioned above, and, second, by the use of oxidation inhibitors to prevent the oil from deteriorating to gums and lacquers which coat the hotter engine parts and are eventually converted by oxidation into coke-like deposits. Three broad classes of oxidation inhibitors are commonly used: (1) phenolic compounds, such as ditertiary butyl paracresol; (2) sulfur and/or phosphorus compounds, such as zinc dithiophosphate; and (3) nitrogen compounds, such as substituted naphthylamines and substituted diphenylamines.

—Gerald Fisher

CORRECTION

In the article, "Dehydrogenation by the Houdry Process," Refining and Petrochemical Edition, November, 1954, due to copying errors, etc., the price of butane in the first line of the subhead, page C-7, should read "5.5 cents per gal," instead of "10 cents per gal." Just following the words, page C-10, paragraph 2, under "Cost of Producing Butadiene" "On the basis of this study the cost of butadiene is 9.88 cents per lb" insert the following: "If normal butane is available at 5.5 cents per gal, and 11.64 cents per lb," and continue with "if the cost of normal butane is 10 cents per gallon."

Also under Table 5, page C-10, following "Production 26,500" the expression should be "ton/year," instead of "ten/year."

— Editor

REFINING AND PETROCHEMICAL PERSONALS

W. F. Jamison, S. T. Carter, and D. W. Wells, employees of Phillips Petroleum Company's Judkins, Texas natural gasoline plant, recently received awards for successfully reviving with artificial respiration James Hamilton, who was a victim of asphyxiation of hydrogen and sulfide gas. George P. Bunn, manager of Phillips natural gasoline department, presented the awards.

▸ **John M. Olin** has been elected chairman of the board of Olin Mathieson Chemical Corporation, and **Thomas S. Nichols** was named president. **John W. Hanes** was elected chairman of the finance committee and vice president for finance. **F. Stillman Elfred, John C. Leppart,** and **Stanley de J. Osborne** were elected executive vice presidents.

Other officers elected were: **Russell R. Casteel,** vice president; **Norman H. Collisson,** vice president for operations; **Donald W. Drummond,** vice president for operations; **R. L. Hockley,** vice president for operations; **Russell Hopkinson,** vice president for development; **Robert W. Lea,** vice president for organization; **R. B. Lewis,** vice president for financial analysis; **David T. Marvel,** vice president for sales; **Milton F. Meissner,** vice president for operations; **S. L. Nevins,** vice president for operations; **Walter F. O'Connell,** vice president and assistant to the vice president for finance; **Fred Olsen,** vice president for research; **Ralph A. Ostberg,** vice president for production; **J. J. Toohy,** vice president for operations; **Theodore Weicker, Jr.,** vice president for overseas operations; **Edgar W. Taft,** treasurer; **C. C. Tallman,** comptrolier; **Gordon Grand, Jr.,** secretary; **E. R. Van Vliet,** assistant treasurer, and **A. P. Winsor,** assistant secretary.

▸ **Dr. Egon I. Sudy** has been appointed to the staff of Foster D. Snell, Inc., consulting chemists and engineers. With offices at Jose M. Montero 2931, Montevideo, Uruguay and in Buenos Aires, Santiago, Chili, and in Sao Paulo, Dr. Sudy will be the technical representative for Foster D. Snell, Inc., in Argentina, Brazil, Chile, and Uruguay. Previously chief chemist of Pharmacia, Inc. and deputy manager of the Paris Subsidiary of Richard Hudnut and Warner Brothers, Dr. Sudy has a Ph. D. and M.S. in chemistry from Budapest University.

▸ **R. O. Norris** has been appointed laboratory director of Cities Service's Petty Island Laboratory. He succeeds R. D. Kleene.

J. R. Mares

B. C. Kirtley

H. B. Peters

▸ **Joseph R. Mares** of Dickinson, Texas, after completing 25 years of service with Monsanto Chemical Company, has launched an industrial chemical consulting practice specializing in petrochemicals and allied products. The former vice president and general manager of Monsanto's Texas City operations was director of the patent and development department at the company's headquarters in St. Louis before moving to Texas in 1947.

▸ **Bruce C. Kirtley,** formerly with M. W. Kellogg Company, recently joined the catalyst division of the National Aluminum Corporation in a technical sales capacity. Headquartering in Houston, he will represent Nalcat in the Gulf Coast area. A member of the Kellogg organization for eight years, Kirtley was engaged in catalytic cracker design and, more recently, in the supervision of new unit start-up operations.

▸ The **R. W. Stafford Company,** consulting gas engineers, of Evanston, Illinois, announces the addition of **Marshall G. Cook** to its staff. Cook was formerly executive assistant division manager of the Indianapolis Division of Phillips Petroleum Company. He has been with the Phillips organization in several capacities with offices at Chicago, Des Moines, Iowa, and Bartlesville, Oklahoma.

▸ **Dr. Everett C. Hughes,** chief of the chemical and physical research division of the Standard Oil Company of Ohio, Cleveland, has been elected chairman of the Division of Petroleum Chemistry, the largest division of the American Chemical Society. He will take office on January 1, 1955, succeeding **Professor Frederick D. Rossini,** head of the department of chemistry in the Carnegie Institute of Technology.

Dr. Alex G. Oblad, director of chemical research for the Houdry Process Corporation, Marcus Hook, Pennsylvania, was named chairman-elect, and **Wheeler G. Lovell,** associate director of research of the Ethyl Corporation, Detroit, was re-elected secretary-treasurer.

Chosen to represent the division's six geographical areas on the division executive committee were: **J. S. Ball** of the United States Bureau of Mines, Laramie, Wyoming; **Philip C. White** of the Standard Oil Company of Indiana, Whiting; **Dr. Vladimir Haensel** of the Union Oil Products Company, Hinsdale, Illinois; **Dr. Max Neuhaus,** Jefferson Chemical Company, Inc., New York; **Dr. A. C. Patterson** of the Standard Oil Development Company, Linden, New Jersey, and **Dr. Jerry McAfee** of the Gulf Research and Development Company, Pittsburgh, Pennsylvania.

▸ **H. B. Peters** has been appointed chief engineer, refining department, of The Texas Company. Peters, formerly an assistant chief engineer, succeeds **David W. Carswell** who has retired after 37 years of service with Texaco, the last 17 years as Chief Engineer. In other promotions, **Francis Horton** and **J. C. Neyland, Jr.,** were appointed to serve as assistant chief engineers along with **R. E. Nagle** who continues in the post. Peters was graduated from Cornell University with a B.S. in civil engineering in 1915. He joined The Texas Company as a draftsman in 1925.

▸ **John A. Tench** has been appointed manager of the Houston refinery of Shell Oil Company. He was formerly manager of the Martinez, California, refinery. Tench started with Shell in 1928 and became refinery manager in 1949. In his new position he succeeds **Paul E. Hurley,** who died recently.

REFINERY PLANTS SCHEDULED FOR COMPLETION

Olefin splitter for Texaco. Texas Company has let two contracts to Catalytic Construction Company, for refinery expansion jobs. One is the over-all job of building some 23 miles of piping for an alkylation unit tie-in at Eagle Point, New Jersey, plant. Second is an olefin feed preparation splitter unit at Westville, that will remove olefins from refinery gases and vapors that will be fed to the alkylation unit. Completion of both scheduled for December, 1954.

★ ★ ★

Another ammonia plant. Still another ammonia plant, this time based wholly on coke oven gas, is to be built on the I&N Railroad at Ketona, Alabama, by Ketona Chemical Corporation, owned by Hercules Powder Company, and Alabama By-Products Corporation. To be built by Fluor Corporation, it will have 45,000 tons annual capacity of ammonia, to be operating by late 1955.

★ ★ ★

Lithium Chemical Plant. Manufacture of lithium chemicals at San Antonio, Texas, will be carried on by American Potash and Chemical Corporation, via plans completed recently. The company actually owning the plant is American Lithium Chemicals, Inc. Ore will come from the parent company's Southern Rhodesia, Africa, deposits where large reserves are owned. Capital requirements are more than $8,000,000. Lithium is employed in the refining industry largely in the manufacture of lubricating greases, especially the all-weather types.

★ ★ ★

Stanolind Louisiana Plant. A quarter-century-old refinery at Vivian, Louisiana, owned by Stanolind Oil and Gas will be closed April, 1955, that company announces. Most, or all, of the 85 employees of the plant will be absorbed by the Brownsville, Texas, synthetic fuels-and-chemicals plant of the company. Equipment at the refinery will be turned over to Pan-Am Southern Corporation for salvage. Plant has operated on Pine Island and Caddo, Louisiana, crudes of late, largely making gasoline and jet fuel for the government on contracts expiring about April 1, 1955.

★ ★ ★

C. S. West Texas Plant. Cities Service's new Gaines County, Texas, gasoline plant at West Seminole has been placed in operation, says Frank M. Perry, vice president of Cities Service Oil Company and manager of its gasoline and chemical operations. Plant will process originally 21 million cu ft of raw gas from West Seminole and Russell fields. Atlantic Refining, Burdell Oil Company, Magnolia Petroleum, Superior Oil Company, Sinclair Oil and Gas, Shell Oil, and Great Western Drilling Company, are joint owners of this plant, which is 22 miles east of Hobbs, New Mexico.

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Anglo-Iranian Oil Company. The 120,000 bbl refinery of Anglo-Iranian at Aden, Arabia, is 98 per cent complete, and has one 60,000 bbl per day crude unit and the sulfur dioxide production and extraction units on stream, report says. The 2500 British, American and European technicians and engineers, as well as the 10,000 Arabs, Indians, and Somalis are being flown home via specially chartered aircraft as the work nears completion. Some 250 British and 1500 Arabs and Indians will replace them, to operate the refinery. Four steamer berths at the port have been completed. The second crude unit, a platformer and an autofiner unit, began operations in October.

★ ★ ★

LPG Unit. Three new units, including the first LPG unit in New England, have been completed. LPG unit will produce 1000 bbl daily of liquefied petroleum gases for New England. The other units are a Girbotol unit for purifying hydrocarbons of sulfides and a 13,500 bbl per day vacuum asphalt pipe still. Formerly the liquefied petroleum gas market in New England was supplied via tank car from Louisiana and Texas refineries. Engineering work for the LPG and asphalt plants was shared by J. P. O'Donnell, Engineers, and Standard Oil Development Company.

★ ★ ★

Sinclair and Standard of Indiana. A new ammonia plant to employ byproduct refinery-produced hydrogen from local refineries of Sinclair and Standard of Indiana, is to be built by these two companies jointly. Plant will make 300 tons of ammonia daily, and will be the largest byproduct hydrogen plant in the U. S. A. Construction starts in the spring of 1955, and is to be completed about a year later. Standard will supervise construction, and operate the plant, located in Hammond, Indiana.

★ ★ ★

Socony-Vacuum Oil Company. Design, engineering, and construction of a 20,000 bbl per day Sovaform unit at Socony's Paulsboro, New Jersey refinery has been contracted by the company with Fluor Corporation, of Los Angeles. The work is to be done largely in and from Fluor's Mid-Continent division at Houston, Texas. A prefractionating unit, revamped from a thermal reformer unit at the refinery, will be built to process 14,500 bbl per day naphtha feed; a new stabilizer section will be included.

★ ★ ★

Gulf Research and Development Corporation. Expenditure of $2,400,000 to build 2 new buildings, a tank farm, and a power house is the latest plan of Gulf in expanding its fuels and lubricants research facilities; the whole constituting mainly a new automotive research laboratory. Trimble Company, Pittsburgh, has construction contract, and units are expected for completion in 18 months. Tankage will triple the present capacity at the laboratories; blending facilities will be expanded greatly in a 2556 sq ft building. New test engines will be installed in a 243-ft long building, 2-storied and with 3 one-story wings, and containing 17 separate engine testing rooms, with 3 additional cold rooms for tests down to minus 70 F.

Trinidad Leaseholds (Canada). A new 1500 bbl per day Platformer in Trinidad's Port Credit, Ontario refinery is in operation as the first step in the company's modernization-expansion program. Platformer is second unit of the type to go on stream in Canada. The Procon-built unit went on stream just five months after breaking ground for it. Its design permits increasing its throughput to 2300 bbl per day when wanted. Running now on Redwater and Trinidad crudes, the reformer in the future will use Canadian crudes.

★ ★ ★

Standard Oil Company (Ohio). Contract for a 300-ton daily unit to synthesize ammonia and make other nitrogen derivatives has been let to M. W. Kellogg Company. Plant will be built in the Lima-Toledo area at an estimated cost of $17,000,000.

★ ★ ★

Union Oil Company. Work has been started on Union's new 20,000 bbl per day coking plant on a site some 14 miles northwest of Santa Maria, California. Major installations will include twin cokers, a 43-ton per day sulfur plant, and other general facilities. The plant, when it goes on stream, will use crude that it pipelines from the Santa Maria oil field.

★ ★ ★

Brea Chemicals, Inc. Two multi-tube reformer furnaces are included in the ammonia plant recently completed for Brea, a subsidiary of the Union Oil Company of California. Design, engineering, and procurement services for the furnace installation were performed by The Girdler Company. C. F. Braun and Company was the prime contractor. Natural gas and steam are reformed catalytically in these furnaces as the first step in the preparation of hydrogen for ammonia synthesis gas. The furnace effluent is further processed by CO conversion and liquid nitrogen scrubbing.

★ ★ ★

Sun Oil Company. Sun has let a contract to Catalytic Construction Company for the process design, engineering and construction of the new $9,000,000 anhydrous ammonia plant to be built at Marcus Hook, Pennsylvania. Engineering work on the project has already begun and construction work in the field is scheduled to begin in January, 1955, with completion set for November, 1955. The ammonia syntheses step is unique for plants of this size as it employs a single converter for the entire output. Plant will utilize byproduct from Sun's Houdriformer unit.

CORRECTION

Capacity of Pan-Am Southern Corporation's new Ultraformer unit at El Dorado refinery, Arkansas, is 7200 bbl daily of charge stock, instead of 730 bbl per day as misstated in our October, 1954 Refining and Petrochemical Edition, page C-66, first paragraph.

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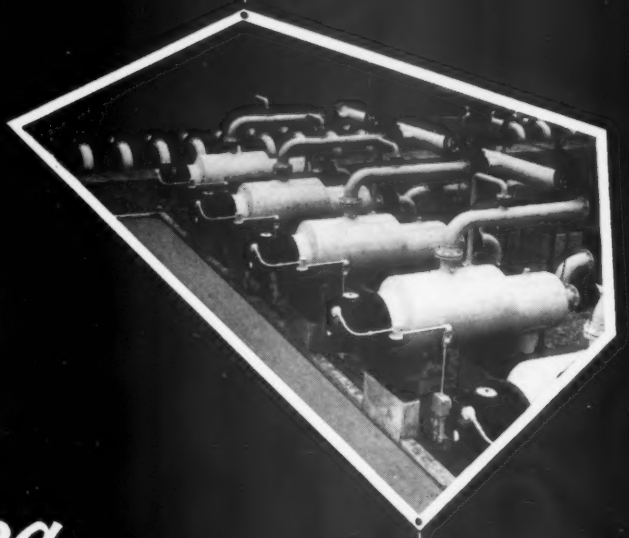

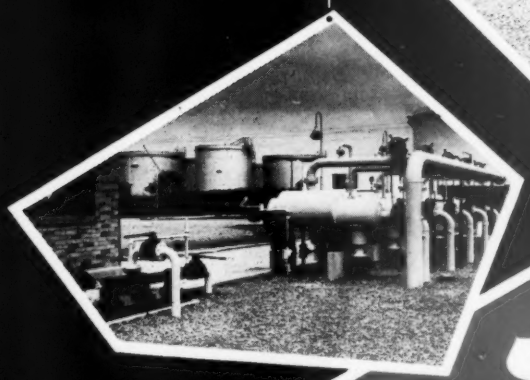

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Gas Revenues Up

Operating revenues of gas pipe line companies reporting to the FPC showed a 15.5 per cent increase for the 12-month period ending August 31, 1954. Total for the period was $1,538,526,834. Net income for the period was over $162,000,000, up 7.9 per cent compared to the like period ending August 31, 1953.

Gas sales to other utilities for resale for the period were 4,812,983 million cubic feet, up 313,820 million cubic feet over the prior 12-month period. Cost of purchased gas was up 17.7 per cent and transmission expenses were up 14.1 per cent.

★ ★ ★

Oil Movements

Traffic was down and revenues up in the third quarter of 1954 for 62 pipe line companies reporting to the ICC. A 2.4 per cent decline in movements was reported, with the 1954 July to September period listing 890,961,075 bbl, compared to 912,531,850 for a like period in 1953.

Revenues increased 0.4 per cent, however, showing $139,873,603 for 1954 in the third quarter, compared to $139,374,789 in 1953 for same period.

Greater volume for the 1954 third period was reported by 20 companies, 36 showed less volume, and six offered no comparative figures. Volume leader was Gulf Refining Company, up 5.7 per cent. Humble Pipe Line was second, off 16.5 per cent.

★ ★ ★

Pipe Line Carries Barter

New pipe lines seem to be the main answer to Bolivia's foreign exchange difficulties. YTFB (Yacimientos Petroliferos Fiscales Bolivianos) is working on a barter agreement with Chile to supply gasoline in exchange for iron and steel products. The pipe line being laid to North Argentina will enable Bolivia to sell a reported 10,000 bbl a day on the Argentina market.

★ ★ ★

Defense Pipe Lines

A group of consultants headed by Charles A. Thomas of Monsanto Chemical has been named by the ODM to study the West Coast Pipe Line project (Texas to California) and the feasibility of a government guarantee against loss for investors if the line operates below its break-even point of 75,0000 bbl daily at 60 cents.

Re-elected

L. H. True, president of Magnolia Pipe Line, has been reelected chairman of the Committee for Pipe Line Companies, an association of nearly all of the nation's interstate and large intrastate carriers of crude oil and petroleum products. Other officers named for the coming year include O. Q. Lomax, president of Humble Pipe Line, vice chairman, and Paul J. Bond, vice president of Pure Transportation, reelected treasurer.

★ ★ ★

LPG Line for Canada

A 450-mile products pipe line designed primarily to handle LPG, first of its kind for western Canada, is being planned for 1955 construction as the first stage of a 5-year plan to bring propane-air mix and similar products to Winnipeg as a supplement to natural gas at times of peak load. The $20,000,000 project is planned by Winnipeg and Central Gas Company, sole franchise holder for natural gas distribution in the Winnipeg metropolitan area.

Lack of underground storage for gas to create a reserve for wintertime high load factor is chief reason for the line, officials said. Surveys and engineering on the line, which will have a minimum diameter of 4-in., probably much larger, are underway. Terminals for distribution of LPG and other products in the big potential market area of the eastern Canadian prairies are also planned. The company plans to construct the line with its own crews.

"THAT'S EXACTLY WHAT THE WEATHERMAN PREDICTED—LOCAL SHOWERS!"

Fast Work

Crude shipments have already begun through sections of the Arapahoe and Western pipe lines, new outlets from the Rocky Mountain area. First shipment through the Arapahoe (Pure-Sinclair joint ownership) was from Schurr Station in Kansas of Humboldt, 168 miles. Remainder of the 479-mile 18 and 20-in. carrier will be in operation before January 1.

Initial shipment through Western was from Laton, Kansas, station through 250 miles of 24-in. to Freeman, Missouri. Balance of the 630-mile line is 20 and 22-in. The entire line was completed in 61 days from first right-of-way clearing and a mid-December target date for operation has been set. Western is a wholly-owned subsidiary of Service Pipe Line.

Both lines will move Rocky Mountain crude to connections with trunk lines serving midwestern refining areas.

★ ★ ★

News Nuggets:

A miniature totem pole will serve as an item of decor and reminder of work on the Alaskan Military products pipe line in Williams Brothers' recently completed office expansion at Tulsa. The firm has added 2500 sq ft to its space and consolidated its formerly widespread departments on one floor.

Hudson Engineering Company of Houston has been awarded a $30,000,000 contract for construction of an extensive gas gathering system and a processing plant in the state of Baluchistan of West Pakistan. The system will be for the Sui gas field. A 350-mile, 16-in. transmission line to Karachi, capital city of 1,500,000 on the coast, is under construction.

Inland Corporation has announced plans to construct immediately 37.5 miles of 10-in. products pipe line between Toledo and Fostoria, Ohio, paralleling an existing 6-in. line. Firm is also considering a 51-mile, 8-in. line between Fostoria and Lima. Inland is owned jointly by Standard of Ohio and Shell.

Husky Oil Company has acquired the H. Earl Clack Company of Havre, Montana, in exchange for a sizable block of Husky stock. The deal includes an interest in the Yellowstone products pipe line between Billings, Montana, and Spokane, Washington, along with 200 wholesale and retail outlets in the Northwestern states.

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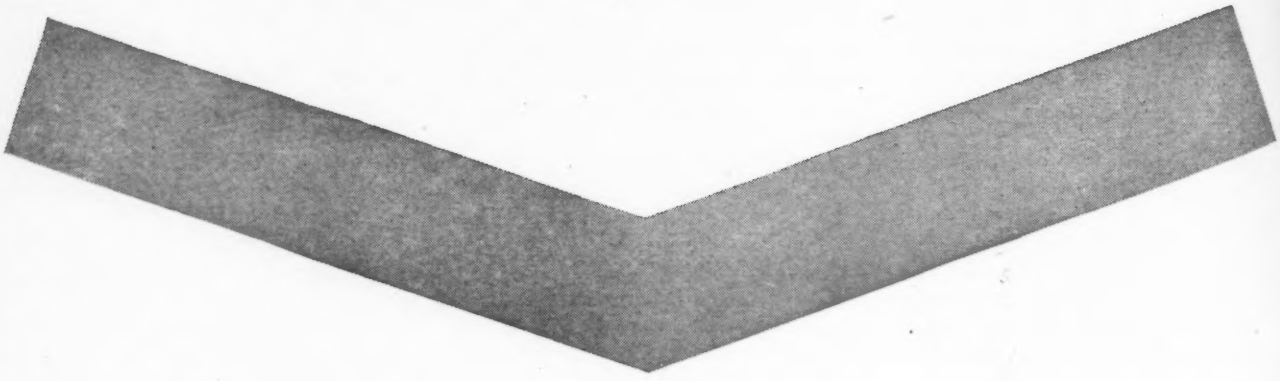

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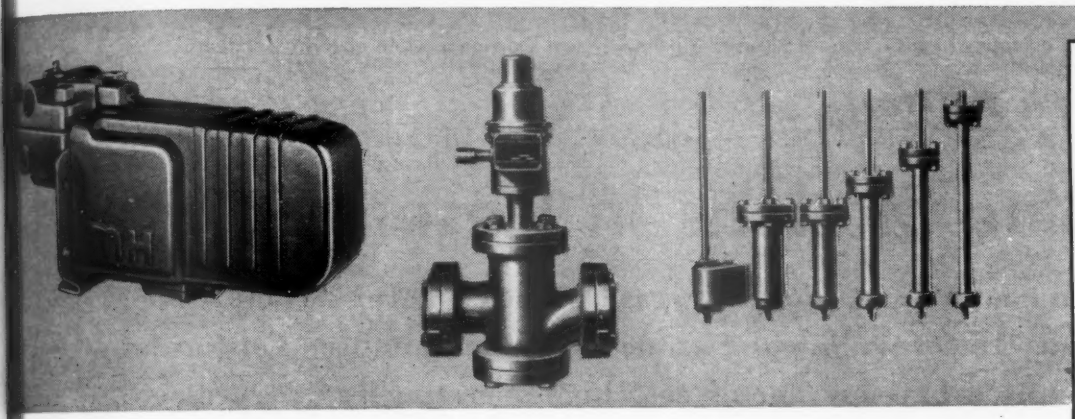

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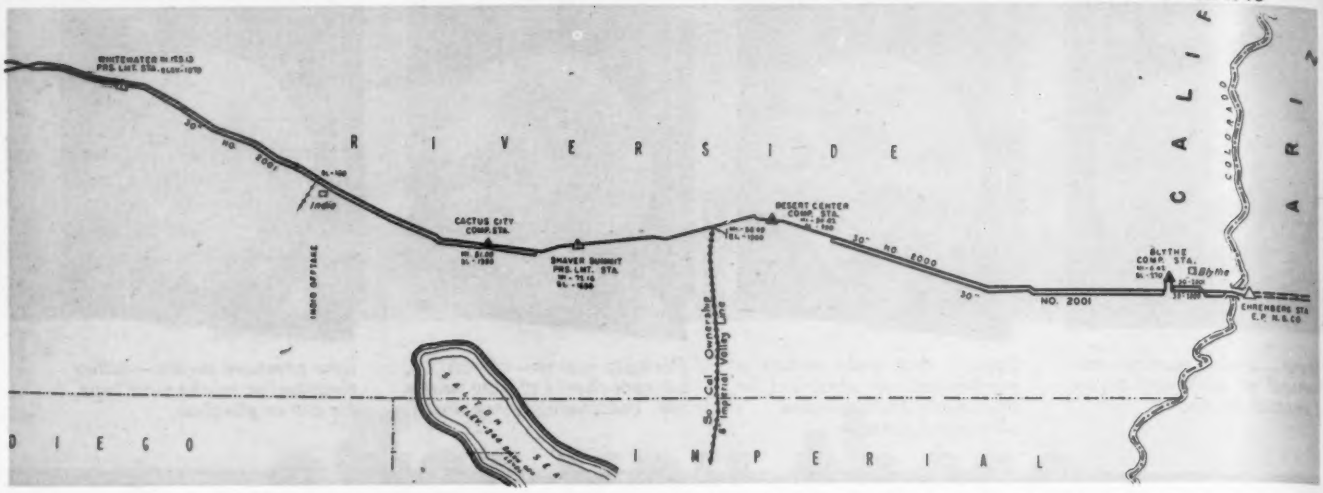

FIG. 1. Portion of operating map of Texas-California Pipeline System showing location of turbine stations.

705,000,000 Cu Ft Daily

Gas Turbine Stations In Desert Country

California-bound natural gas boosted by gas turbine-centrifugal compressor stations on Texas-California line of Southern Counties-Southern California Gas Companies; units have low annual cost, high operating time percentage

G. V. VAIL and M. M. McMAHON

TWO compressor stations utilizing combustion gas turbine driven centrifugal compressors were recently placed in operation on the Blythe to Los Angeles, California, natural gas transmission pipe line of the Southern California Gas Company and Southern Counties Gas Company. Natural gas gathered by El Paso Natural Gas Company in the Texas Panhandle. The Permian Basin of Texas and New Mexico, and the San Juan Basin of New Mexico and Colorado is delivered to the two companies at the Arizona-California border near Blythe. It is the function of the Southern California pipe line to deliver this gas to the major centers of distribution in the Los Angeles Metropolitan area, to connecting pipe lines that supply gas to the Imperial and Coachella valleys and a portion of the requirements of the San Diego area.

EXCLUSIVE

Tremendous population and industrial growth in southern California, with the resulting increased demand for natural gas, led the managements of the Southern California Gas Company and Southern Counties Gas Company of

FIG. 2. Main unit—air compressor station.

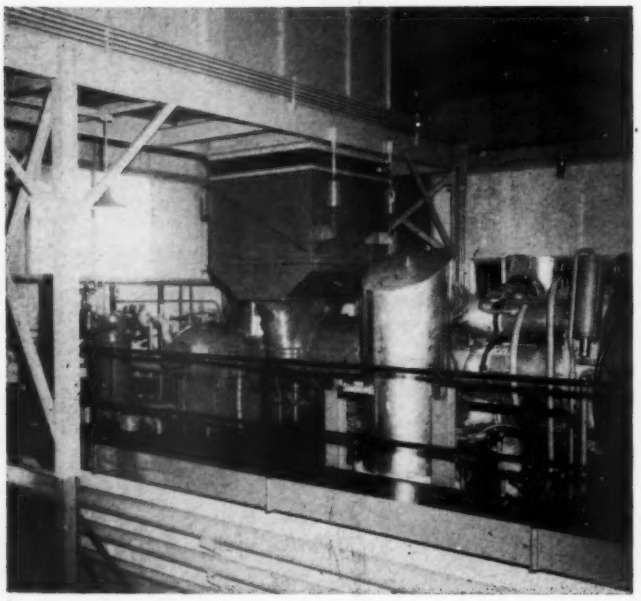

FIG. 3. Gas compressor, showing motor operated suction valves

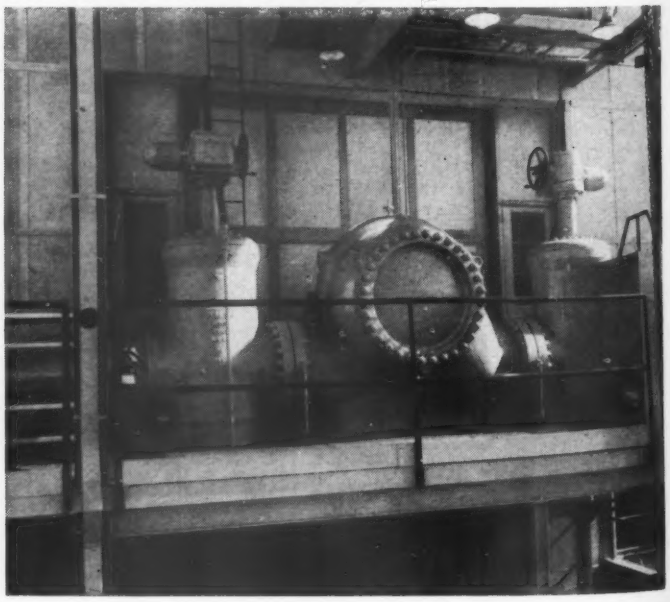

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FIG. 4. General view of station showing inlet scrubber station piping and main building.

California to initiate plans that resulted in the first delivery, in November of 1947, of gas from Texas and New Mexico to customers in California. The transmission facilities used in Southern California to transport out-of-state gas have been built and operated by Southern California Gas Company and Southern Counties Gas Company as tenants in common.

The original Blythe to Los Angeles pipe line was a single 30-in. line from the Colorado River near Blythe to Santa Fe Springs. A 26-in. connecting line delivered gas from Santa Fe Springs to Spence station in the center of Los Angeles. The initial capacity under these conditions was 175,000,000 cu ft per day. This rate was reached in January, 1948.

To keep pace with the continued rapid growth of Southern California, step by step increases were made in the rates at which out-of-state gas was purchased. A compressor station with seven 1600-hp reciprocating gas engine driven compressor units was put in operation in 1948. This station raised the operating pressure near Blythe to 807 psi, maximum design pressure of the pipe line, and normal capacity of the line was increased to 305,000,000 cu ft per day. By fall, 1950, with completion of a 30-in. loop line, 83 miles in length, from Whitewater station to Puente station and increasing size of the Blythe plant to 10 units with an aggregate total horsepower of 16,480, the nominal system capacity became 410,000,000 cu ft per day.

In 1952, arrangements were completed for the purchase of an additional 151,000,000 cu ft daily of out-of-state gas. The facilities installed to increase the Southern California system capacity to 561,000,000 cu ft daily were a 6-mile loop line between the Colorado River and the Blythe compressor station, a 14-mile loop extending westward from near Indio, two additional 1760-hp reciprocating compressor units in a new plant adjacent to the existing Blythe station, and the 2 combustion gas turbine driven centrifugal compressors located near Desert Center and Cactus City. The centrifugal compressor station near Desert Center went on the line on August 10, 1953, and the one near Cactus City went in service on September 14, 1953.

Based upon the forecasted growth of requirements and anticipated decreasing supply from California gas sources, still another increment of out-of-state gas of 151,000,000 cu ft daily was contracted for, and the necessary certificate of public convenience and necessity was granted in mid-1953. The added facilities necessary to increase the nominal system capacity of the Southern California system to 713,000,000 cu ft daily are now nearing completion. The pipe line facilities are an 11-mile 30-in. loop eastward from Whitewater station to connect with the existing loop west of Indio, a 19-mile loop between Cactus City and a point near Indio, a 5½-mile loop eastward from Cactus City, and a 37½-mile loop westward from the Blythe compressor station. Three additional 1760-hp reciprocating compressor units are being installed in the new plant at Blythe. Additions to auxiliaries and station piping will also be required at Blythe, and some minor piping additions are being made at the desert Center and Cactus City stations.

All pipe line work of both additions has been completed, and the installation of the 3 reciprocating compressor units at Blythe station is nearing completion. During a test of the system on January 23, 1954, a flow of 745,000,000 cu ft per day rate was reached.

The location of the pipe line, the compressor stations major terminals and connecting pipe lines are shown in Fig. 1. The Desert Center booster is 43.5 miles for the Blythe compressor station, and the Cactus City plant is, in turn, 31.1 miles downstream from the Desert Center unit.

Bases For Choice of Gas Turbines

Several factors influenced the selection of combustion gas turbine driven centrifugal compressors as elements in the facilities necessary to increase nominal line capacity from 410,000,000 to 561,000,000 cu ft daily. Original 1950 plans for the facilities necessary for this increment in capacity included a

M. M. McMahon G. V. Vail

The Authors

M. M. McMahon is administrative engineer in the gas supply department of Southern California Gas Company. He has been also division engineer, production control engineer, and division superintendent for the company. A graduate of the California Institute of Technology, he has been with the company since 1936.

G. V. Vail is plant superintendent in charge of compressor stations for Southern Counties Gas Company of California's Texas pipe line facilities. Before taking his present position he was responsible for plant maintenance at the butadiene plant operated by the company from 1943 to 1947. Prior to that Vail had operating responsibility for large compressor plants operating on gas transmission systems in the Mid-Continent area.

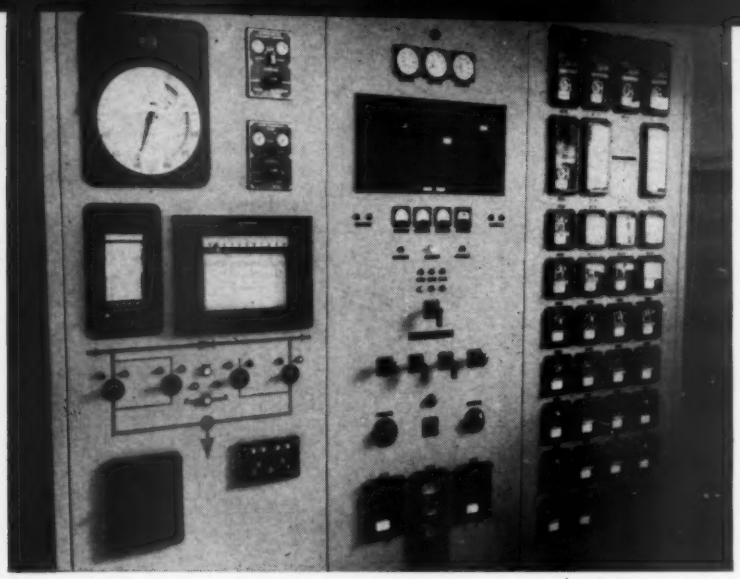


FIG. 5. Electrical control panel.

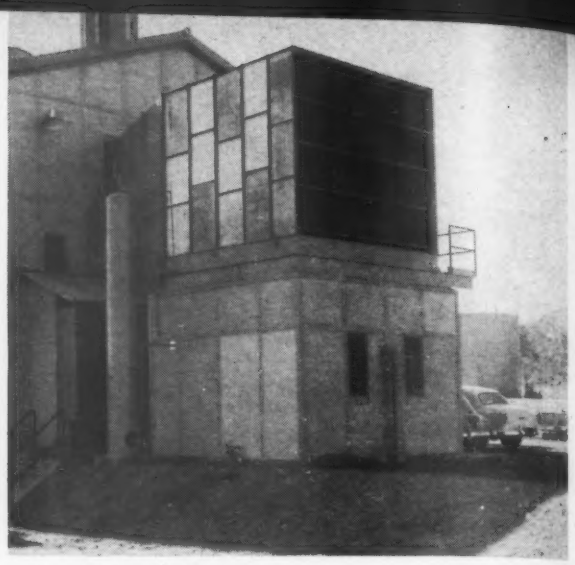


FIG. 6. Air washer.

total of 78 miles of loop line. It soon became apparent, due to the shortage of steel, that sufficient pipe for such a program could not be obtained under the conditions then prevaling. Alternates of 1, 2 or 3 intermediate booster compressor stations were weighed. Based upon consideration of the limited availability of pipe, existing pipewall thickness, low compression ratio, scarcity of water, and anticipated minimum total annual costs it appeared that a system including 2 gas turbine driven centrifugal compressors was well suited for this particular application.

When compared with reciprocating compressors for the low compression ratio required, the anticipated lower capital investment and lower labor costs appeared to more than offset estimated differences in fuel economy and result in lower total annual costs if the gas turbine driven centrifugal gas compressor were to be used.

Facilities at Turbine Stations

The main unit at each of the stations is composed of two major components, the prime mover and the compressor. The main unit is shown in Fig. 2. The prime mover is a natural gas fired 5700-hp regenerative cycle, 2 shaft, combustion gas turbine.[1] The original rating of 5000-hp has recently been raised by the manufacturer to 5700-hp, based upon operating experience. This prime mover is made up of an axial flow air compressor having 14 stages, a combustion system composed of 6 combustion chambers mounted concentrically around the high pressure turbine frame, a high pressure turbine wheel on the same shaft as the air compressor, and a low pressure turbine on a separate load shaft. The shaft of the centrifugal compressor is coupled directly to the load shaft of the prime mover. The normal speed of operation of the air compressor shaft is 6900 rpm, and that of the load shaft, which drives the centrifugal gas compressor, is 5000 rpm.

The compressor at each station is a single stage centrifugal.[2] Compressor is shown in Fig. 3. The maximum design operating discharge pressure of the compressor at Desert Center is 807 psig and that at Cactus City in 725 psig as limited by the design of main line pipe wall thickness. The case and seals of the compressor are designed for a maximum operating pressure of 1000 psig. There has been no provision made to date for cooling of the gas discharged from either of the two stations.

Both major components of the main unit are mounted on a common frame fabricated of structural steel, which is in turn supported by a reinforced concrete foundation.

The over-all length of the main unit, including the cranking turbine and governor assembly is 33 ft. Its width is 13 ft.

At each station, the main unit, together with the small auxiliary and control equipment, is housed in a structural steel frame Transite covered building. The building is 38½ by 62 by 28 ft to the eaves. The operating floor is at an elevation of 8½ ft above ground level, and a lower floor 2¾ ft below ground level provides space for the necessary electrical auxiliaries. This room is directly below the control room. Care was exercised in the design and construction of the building to provide closures capable of minimizing dust entry into the main and auxiliary operating areas. This feature is of importance because the desert location of the plants makes them subject to dust storms generated by occasional high wind velocities. Building arrangement is shown in Fig. 4.

[1]General Electric.
[2]De Laval.

FIG. 7. Regenerator and air coolers.

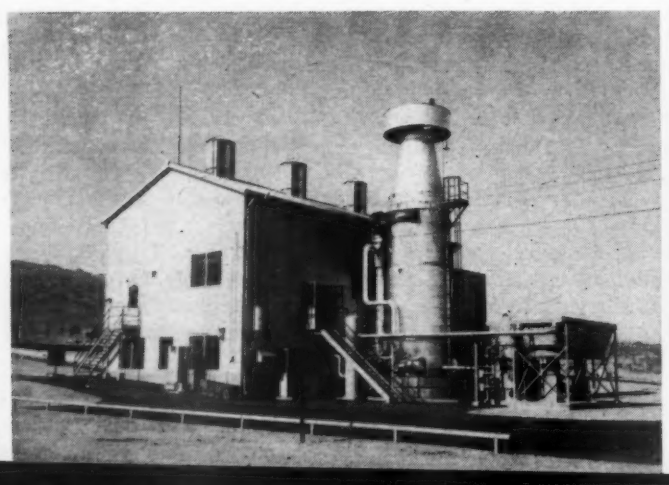
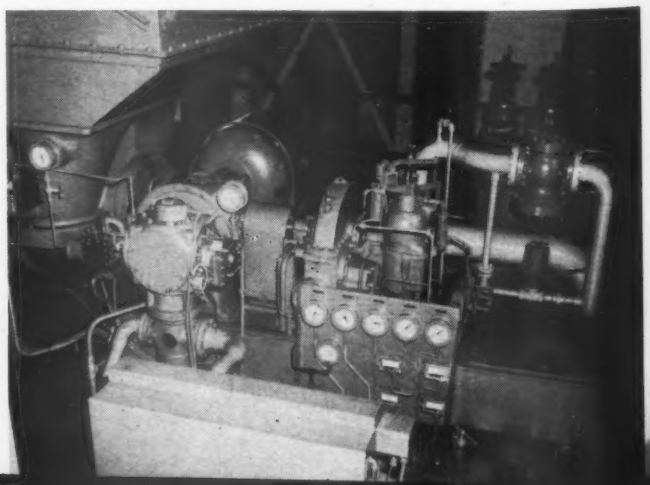


FIG. 8. Main station generator, starting expander turbine and lubricating oil cooler.



On the operating levels a partition, complete with double glassed windows, separates the area occupied by the main unit from the operator's station that contains the electrical control panels and the gage board, which shows operating pressures. The electrical control panel is shown in Fig. 5. Full air conditioning of the interior of the two electrical control panels is provided by a 5-ton unit[3] located on the lower level. Without the temperature controlled dust free air supplied to the panel interiors, it is impossible to secure the necessary electrical circuit protection at this location due to the high ambient temperatures.

Air Supply and Services

Combustion. (a). *Air Washer.* The washer is a steel structure located immediately east and outside of the main station building as shown in Fig. 6. The body of the washer contains sprays and baffles that provide surface for cleaning and cooling of entering air by contact with the evaporation of water in the air stream entering the duct that leads to the combustion air compressor. The electrically driven pumps that deliver water to the sprays in the evaporation chamber are housed in a room enclosed by the steel structure that supports the washer. Washer is capable of saturating the approximately 90.7 lb per sec or 75,000 cfm of combustion air required.

[3]Servel.

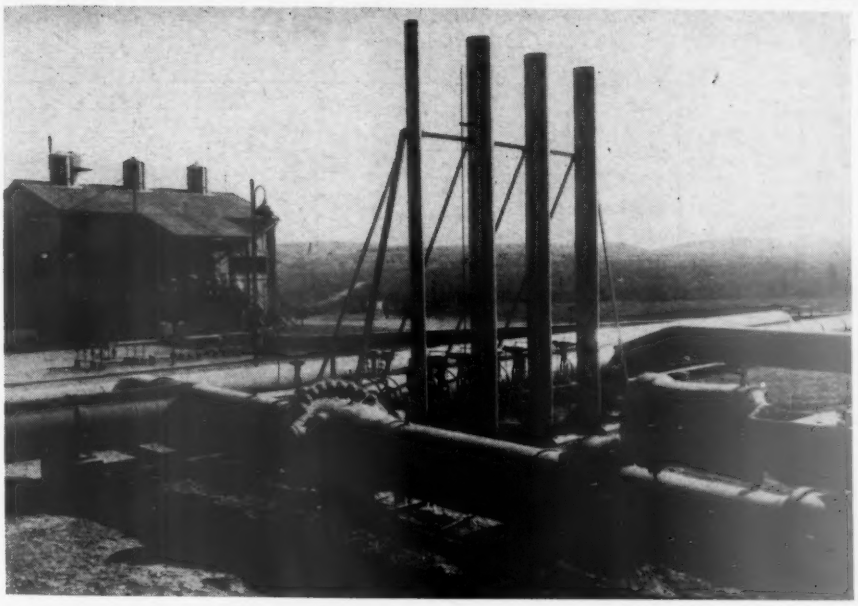


FIG. 10. Inlet piping and relief valves, Cactus City station.

b. *Inlet Silencer.* The inlet silencer is mounted directly on the air inlet casing. It is a case in which 24 vertical removable baffle elements are arranged in such a manner as to reduce the intensity of the high frequency noise generated in the air inlet by the compressor blading. The baffles are made of ½-in. fiberglass insulation enclosed in perforated steel sheets.

Foundation Cooling—An induced draft fan mounted in a tunnel cast in concrete foundation of the main unit draws outside air through an endless chain type oil bath air filter. This air provides cooling for the concrete foundation of the main unit.

Instrument and Auxiliary Electric Plant Starting—Compressor air at 200 psig is provided by an electric motor driven air compressor. For cold starts a gas engine drive has also been provided. This compressor is located in the ground level auxiliary room below the operator's station.

Electrical Control Panel Air Conditioner—A five-ton air conditioner also located in the auxiliary room provides clean temperature and humidity controlled air to the two electrical control cabinets on the operating level. Ingenious use has been made of the spaces between the concrete beams and floor slab of the operating level as distribution ducts for the electrical circuits. These ducts are supplied with conditioned air.

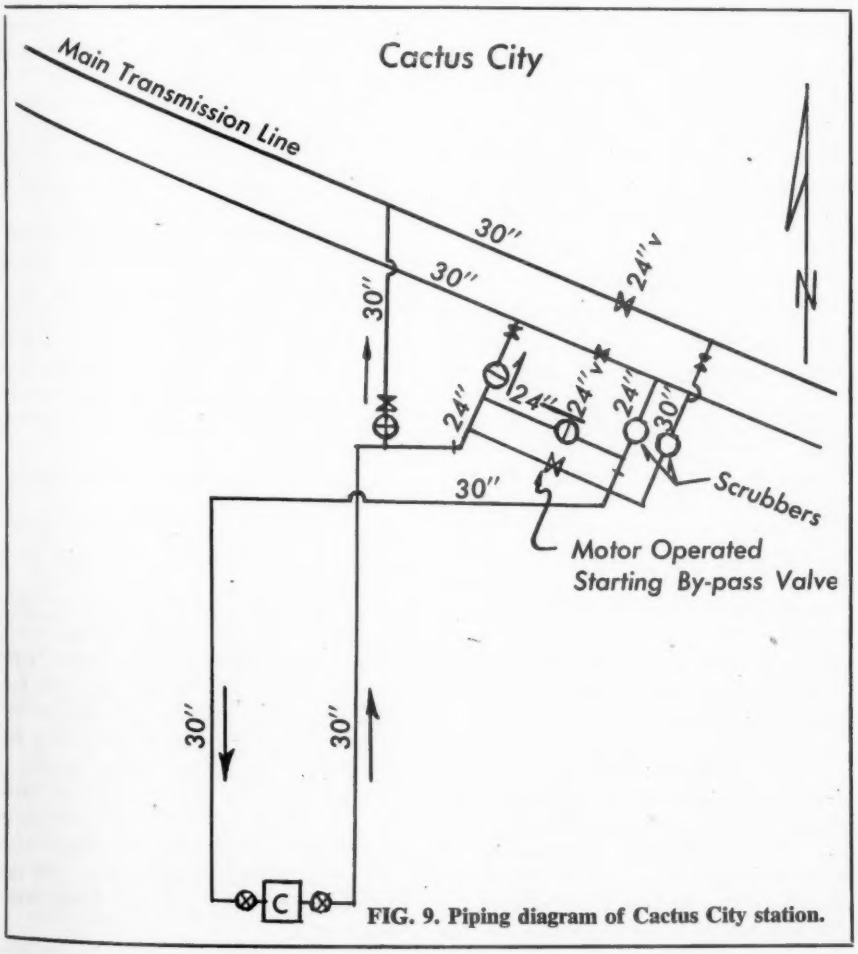


FIG. 9. Piping diagram of Cactus City station.

Water Supply

Primary Supply. Water for use at each station is provided by wells drilled solely for that purpose. At Desert Center the well is located some 3 miles from the plant, while at Cactus City the well is only 1 mile distant. An electric deep well pump at Cactus City and a diesel engine driven deep well pump at Desert City are automatically controlled by the water level in the 1500 bbl storage tanks located in each plant yard, maintaining the desired supply at all times.

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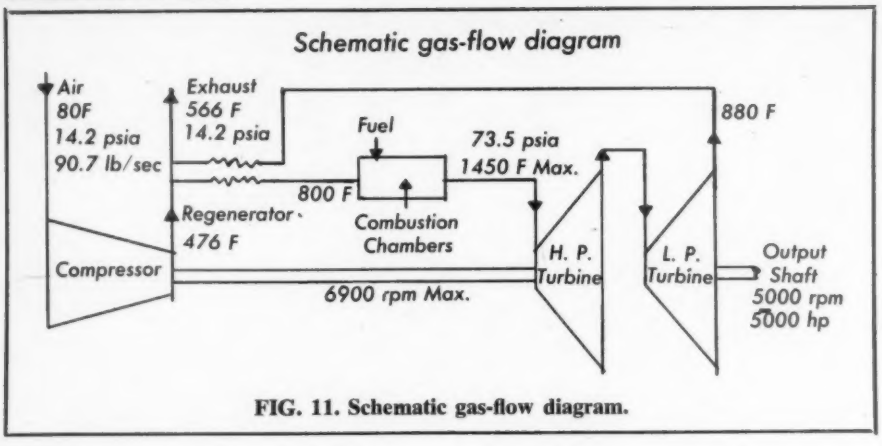

FIG. 11. Schematic gas-flow diagram.

Air Washer. Electric pumps in the washer pump room supply the washer sprays. A sodium zeolite softener is used to treat the water used in the washer. Constant blowdown is employed to control solids.

Cooling Services. The 2 finned tube atmospheric type air coolers, with electric motor driven fans shown in Fig. 7 cool approximately 300 gpm (if cooled water at 85 F) in a closed circuit water system. In turn some 250 gpm of this cooled water flows to an oil cooler[4] located at the starting turbine end of the main unit to cool the combustion turbine lubricating oil. Another stream of 50 gpm of the cooled water flows to an exchanger located in the auxiliary room where it picks up heat from a closed circuit distilled water system, which in turn cools the turbine nozzles and the frame supporting the turbines.

Electrical System

The centrifugal compressor stations are entirely self-sufficient with respect to electricity. A dual ac and dc system provides the necessary flexibility for cold starts.

The dc system is composed of a 60-cell station battery, which provides 125-v direct current to motors on lubricating and seal oil pumps and the gas line valves and circulating cooling water pumps, and an ac motor driven dc generator, which charges the station battery.

The ac system elements include:

1. A 75 kw gas engine driven auxiliary generator that is used as a source of station power when the main unit is not in operation.

2. A 125 kw main station generator that is connected through gearing to the high pressure (air compressor) shaft of the prime mover. This is the normal source of all station power when the main unit is in operation. It is shown in Fig. 8. All normal auxiliary drive motors are supplied ac from the station bus.

The dc motors driving pumps are shut down automatically when the matching ac motor driven pumps provide normal service pressures, as ac becomes available during the starting sequence. AC operation of the pumps during the normal cool down period after shutdown of the main unit is made possible through operation of the gas driven auxiliary generator. This cool down period may extend as long as three hours to avoid misalignment and bearing difficulties that might result from temperature differentials resulting from residual heat within the main unit.

Electrical controls provide for fully automatic starting, operating, and stopping. All functions are electrically interlocked, with annunciators on relays that identify trouble that can occur at any step in the starting sequence. Similar annunciators are connected to the operating controls that provide for automatic shutdown of the main unit in case any of the predetermined limits of combustion gas, oil, and water pressures and temperatures and mechanical vibration amplitude are exceeded.

Regenerator

The regenerator is a large shell and tube type exchanger. It is also shown in Fig. 6, and is located outside the south wall of the main compressor building. It is composed of 5100 vertical 1¼-in. OD tubes having an effective surface area of approximately 46,300 sq ft. The tubes are held in 2 tube sheets in a 10-ft diameter shell. Function of the regenerator is to interchange the heat available in the combustion gases discharged from the second stage or low pressure turbine to the air leaving the axial flow air compressor before this air enters the combustion chambers.

Station Piping

The arrangement of the main gas piping between the transmission lines and the centrifugal compressor is shown in Figs. 9 and 10. A motor operated starting bypass valve, shown on the diagram, is used in putting the station on the line, after the main line valves have been closed.

It was necessary to provide for the movement of the suction and discharge piping between the main lines and the compressor, which results from changing operating temperatures. This was done through installation of forged welding ell angles and runs of pipe supported in trenches on hold downs and guides providing for both lateral and longitudinal movement. At the compressor end of the piping, massive concrete supports and positive acting adjustable hold downs were provided to control the terminal position of the piping. This control was necessary to maintain proper alignment of the compressor—prime mover load shaft.

Meters are provided for measurement of gas withdrawn from the main piping for main unit and auxiliary fuel and for gas used to drive the expansion starting turbine.

The inlet and outlet gate valves, mounted directly on the flanges of the gas compressor case, and the station bypass valve are actuated by dc electric motors. The controls of these motors are electrically interlocked in the starting and stopping sequence, so that proper operation is assured in the automatically controlled series of operations required to place the station in service and shut it down.

Operation of Stations

Flows. The flows of combustion air, fuel, and combustion products through the prime mover and regenerator, with representative values of temperature, pressure, and quantity are shown in Fig. 11. Conditions illustrated are for 5700-hp output to the gas compressor, with the load shaft at 5000 rpm.

Starting and Stopping Sequences. The automatically controlled starting and stopping sequences include a number of operations. To place the station in service, the operator first switches on the dc power from the station battery. He then checks the levels in the lubricating-seal oil and turbine cooling water tanks.

Control switches for the motor operated gas valves are then placed in the automatic start position and the equipment is ready for the automatic starting sequence.

If the gas engine auxiliary ac generator is operating, the operator can start the ac cooling water pumps, nozzle cooling water pump, and the fin-fan units that will be switched to the direct driven main generator when the main unit reaches operating speed.

The operator then pushes the start switch. The dc auxiliary lubricating oil pump and dc nozzle cooling water pump will start and build up the required lubricating oil and water pressures.

[4]Type ES, Ross.

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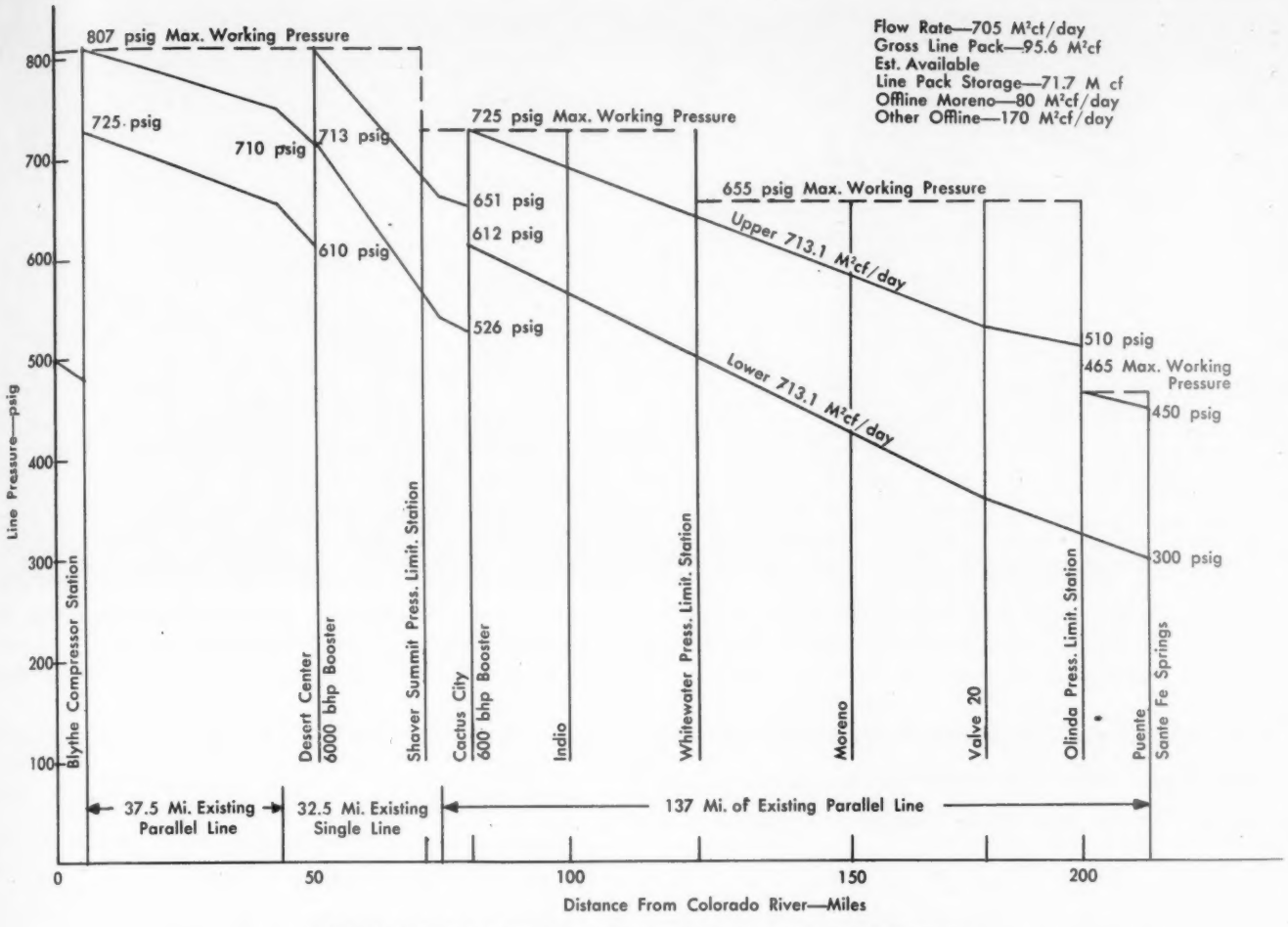

FIG. 12. Blythe to Santa Fe Springs pipe line pressure gradient curve.

The pressure switches in the system will then close, and the unit will start. The starting turbine brings the high pressure air compressor shaft up to 1100 rpm and holds it there for 7½ minutes. Gas expanded from transmission line to atmospheric pressure through the starting turbine provides the necessary power. During this period, the combustion system is purged with air from the axial flow air compressor, and the gas compressor is purged, pressurized, and compressor suction and discharge valves opened.

The combustion turbine fires and accelerates to the high pressure turbine speed of 4500 rpm, at which time the load shaft breaks away and accelerates to 2600 rpm, and the unit is ready to load. At this stage, the direct driven electric generator is out on the line, and the auxiliary unit is shut down. The main line gas valves are first closed, then the station bypass valve is closed. The gas compressor shaft speed is brought up to the desired value.

The speed of the high pressure shaft is then controlled to provide the gas compressor horsepower requirement as determined by the amount of gas being compressed. The operating control is on the exhaust temperature of the load turbine. A temperature actuated governor controlling fuel input operates to hold the desired exhaust temperature. Maximum full load speed of the high pressure shaft is 6900 rpm.

Shutdown of the unit is essentially the reverse of startup, however, some cooling may continue to be circulated for as long as three hours after shutdown to cool bearings and seals and prevent misalignment due to temperatures. Electric power for pump requirements during this period is available from the station battery.

Running Conditions

Maximum discharge pressure operating conditions have not as yet been reached, as installation of the 3 reciprocating compressor units in the Blythe station is not complete. Conditions on January 31, 1954, however, when the flow rate was steady at 713,000,000 cu ft per day were:

	Psig Intake	Psig Discharge	R
Desert Center . .	610	736	1.20
Cactus City . . .	535	632	1.18

On the day of maximum throughput to date, when 751,000,000 cu ft was compressed in the 24 hours, the 11 a.m. values were:

Desert Center . .	650	782	1.20
Cactus City . . .	581	675	1.16

Cumulative operating statistics of interest are shown in Table 1.

The chart in Fig. 12 shows the anticipated operating conditions for varying levels of flow and quantities of gas stored within the pipe line system, computed on the basis of 6000 hp of each of the turbine stations. The stations are run by a single operator on each shift. These operators live in the towns of Blythe and Indio and drive to the stations daily. Maintenance is performed by a company crew.

TABLE 1. Cumulative operating statistics.
Desert Center and Cacrus City stations
From October 1, 1953 to June 1, 1954

	Units	Desert Center	Cactus City
Total elapsed hours	Hours	5831	5831
Actual hours in operation	Hours	5208	4768
Per cent operation	Per cent	89.5	81.8
Operating hours lost to main unit trouble	Hours	12	5
Per cent loss due to main unit trouble	Per cent	0.2	0.1
Operating hours lost due to instrument and control shutdowns	Hours	28	28
Per cent loss due to instrument and control shutdowns	Per cent	0.5	0.5
Operating hours lost due to inspection of units	Hours	322	304
Per cent loss due to inspection	Per cent	5.4	5.1
Operating hours lost due to other operations—dispatching, tie ins, line tests with stations out of service and lack of loads	Hours	261	726
Per cent loss due to other operations	Per cent	4.4	12.5

Driving between banks of snow pushed aside by the snow plow, a Service Pipe Line gager passes the Mendenhall tank battery, left. The producing company, Amerada, spent about $300 an hour removing snow so workers could get to the wells.

Talk about cold weather! Problems increase manyfold when temperatures drop below zero and stay there for days

Experiences in Sub-Zero Pipelining

CARL I. HUSS*

NORTH DAKOTA had an above-normal winter during 1953-54, except for three weeks in January when the mercury forgot to climb out of the thermometer bulb. Despite the rugged weather, Service Pipe Line Company employees continued to operate the state's only crude oil pipe line, and give transportation to producing wells in the Tioga-Beaver Lodge fields.

The first indication Service's Tulsa office had of the cold weather was a run ticket from district gager Charles Kruger at Tioga. The run ticket records all information about the quantity and quality of oil in a producer's lease tank before it enters the pipe line. Since the volume and gravity of oil changes with the temperature, 60F has been adopted as a standard for measurement. Tables have been worked out to convert volume and gravity measured at other temperatures to the volume and gravity at 60 deg.

Kruger's run ticket showed the oil was three degrees below zero and none of the conversion tables at Tulsa went that low. In fact, none in the industry go below zero.

Puzzled clerks in the oil run section called Rudy Hamill, assistant chief gager, and told him their difficulty. Hamill asked Lee Nations, tank table engineer, to compute the tables to minus 10 deg. Nations computed the table —15 deg, thinking surely that would be low enough. Not so. A run ticket from Kruger dated January 19 came in with a closing gage temperature of—18 (the coldest gaged oil in company history).

The Williston weather bureau, about 60 miles from Tioga, gave—3 deg as the average temperature for January. For 7 days, from January 12 to 21, the thermometer never struggled above —6 deg and one night slid to —39 deg. Tioga, according to Service employees, is usually 5 to 10 deg colder than Williston.

The bottom literally fell out of a company thermometer on the coldest night when unofficially the temperature at Tioga fell to—47 deg. Division gager Charles Dougherty left a gagers thermometer in his car that measures temperatures to—40 deg. Next morning he found it broken, he thinks, by the cold.

That same morning, George Abbey, district clerk, arrived at the company's Tioga office to find the fuel oil in the 300-gal tank congealed so that it would not flow to the stoves.

Milton Back, connection foreman, called in that his pickup truck was stuck in a snowdrift. His car had two flat tires. His water lines and the propane tank that supplied fuel for his home were frozen. He said that he "might be a little late."

Other employees complained that the headbolt heaters in the water jackets of their car engines were kept on all night, yet did not keep the engines warm enough to start that morning. (The heaters are mounted on the car engine. When the car is put away for the night the driver plugs the heater into an ordinary 110-volt house circuit. It warms the oil and water in the car engine.) Lube oil froze so solid

*Service Pipe Line Company, Tulsa, Oklahoma.

EXCLUSIVE

Searching for flanges at the loading rack site, district clerk George Abbey, left, and connection foreman Milton Back dig in the drifted snow. All employees were protected with proper clothing.

North Dakota roadside is piled high with snow as Lawrence Miller, district gager for Service Pipe Line Company, makes his rounds. During the unusually severe weather gagers are not able to reach some tanks batteries although their jeeps have four-wheel drive.

What the well-protected loading rackmen wear during North Dakota winters. Rackmen are Clyde Mays, Phillip Bagley and Earl Fetzer, who kept North Dakota oil moving into railroad tank cars despite sub-zero weather. Tank cars waiting to be loaded may be seen faintly in background.

in some cars that the rear wheels would not roll when the cars were towed on dry pavement.

Service uses two types of pumping units in North Dakota. Rotary pumps are used for the low pressure units and plunger type pumps for all high pressure units. The men removed the baskets from the strainers on the units because ice blocked the suction.

Just before winter came at its worst, employees filled all gear cases on the plunger pumps with SAE 30 motor oil instead of the SAE 90 gear lube. At —30 deg, the 25 and 50-hp electric motors would not turn these pumps with bypass valves open. The men removed the SAE 30 oil and put in SAE 10 oil mixed with a small amount of kerosine. Gleason Dryden, division electrician, found that because of frozen grease, the ball bearings in one electric motor were sliding in the outer race instead of rolling.

All Service's pumps stand on 3 to 4-ft fills to allow the wind to blow the snow away from them. Even so, some of them had to be dug out. Snow packed around the sheaves on the belt drive of some units, preventing them from turning. Drifting snow saved gagers the bother of opening fence gates. They simply walked over the fences to the units.

Service has two 12-hp gasoline units temporarily installed in the field where electric power is not yet available. Two men worked two days to start the units. They drained the oil from the crankcase, heated it and put it back in. They changed spark plugs. They took off the magnetos and warmed them before they would fire.

District gagers Kruger and Lawrence Miller and relief district gager Leo Hull could not get into many locations even though they drive jeeps with four-wheel drive.

The producing company, Amerada, spent about $300 an hour removing snow to allow their personnel and Service's gagers to make their rounds, according to Lloyd Whitney, division engineer, but the task was endless as drifting snow closed roads rapidly. Service's trucks with four-wheel drive and snow plow attachment kept busy rescuing gagers with stuck vehicles and opening roads to pumps.

Besides getting stuck, the gagers had other problems. Because air valves failed to operate and tank headers froze up with condensation, split runs were common (tanks that have not emptied within 24 hours are gaged again and another ticket filled out on them. This is a split run.)

The lubricant froze solid in the tank stops and they had to be overhauled before they could be opened. Ice and heavy oil held check valves open and several field tanks overflowed. Producers' tanks overflowed through the gage hatches several times when storms prevented switchers from getting to the wells to shut them down.

Sub-zero weather, however, did not shut down Service's loading rack on the Great Northern Railroad at Tioga. Employees continued to load 50 to 60 cars a day. The loading rack stands out alone where freezing winds have a clean sweep at it, so employees were provided with the best clothing available, including face masks made of felt. The men suffered no ill health or bodily harm from the sub-zero weather during the winter. * * *

Digging out pumping unit on lease, gager Charles Kruger pauses in his work. Kruger, made a closing gage of — 18 degrees, the coldest in Service's history.

XUM

Uniform streams, less sediment by using

Mechanical Mixers In Crude Oil Tanks†

NEIL G. WILSON*

TWO problems of long standing in pipe line and refinery operation are gravity variations in crude oil streams reaching the refinery units and the accumulation of sediment in crude oil tanks. Non-uniformity of crude oil charging stock adversely affects refinery distilling operations. The necessary removal of sediment from tanks is costly, and at locations where reclamation facilities are unavailable valuable refinable fractions are frequently wasted.

An investigation was undertaken to determine if a solution to both problems might be found in a tank stirring device installed at pipe line tank farms for the dual purpose of resuspending sediment and blending[1] dissimilar batch components. It was known that horizontal mechanical mixers had been in use for some time. Consultations were held with five companies using these as well as other types of agitators. Their experience with horizontal mechanical mixers was favorable with respect to preventing bottoms accumulation. Little information, however, was available on procedure to accomplish blending, although in two cases mixers were being used for this purpose. Mixers of other types were reported to be satisfactory for blending purposes, but were unsuitable for preventing sediment accumulation.

From the data acquired during consultations, it was concluded that side-entering, horizontal mechanical mixers were best suited to accomplish the desired results, provided they were economically sound. Therefore an economic evaluation was made from the viewpoint of both pipe line and refinery interests. Following that, tests were conducted to determine optimum mixer procedure to achieve the required degree of crude oil blending. This article is concerned with these two fields of interest.

Economics

From the pipe line view, tank cleaning cost was compared to mixer installation, operation, and maintenance costs. Other factors to be considered were (a) possible increased vapor loss as a result of agitation, (b) effect of increased suspended solids on pumps and seals, and (c) additional power and pipe line capacity necessary to transport BS&W[2]. From the refinery viewpoint an important factor was the effect of additional receipts of foreign matter accumulating on tank bottoms at refinery tank farms, if mixers were not installed there. The possibility of increased fouling of tubes because of additional foreign matter reaching heat exchangers was also to be considered. Offsetting these possible disadvantages would be more efficient desalting and distilling because of uniform composition crude.

Pipe Line Viewpoint

Records of tank bottom build-up in 4 major tank farms were examined. These studies indicated that sediment accumulated at an average rate of about 700 bbl per tank per year in the normal handling of Texas and Oklahoma crudes. In tanks that were worked infrequently or used for seasonal storage, the deposition rate was higher by a factor of 1.5 to 2. Removal of sediment at these farms was necessary every 4 or 5 years. These data also showed an average tank downtime of about 1 month for cleaning, including inspection and maintenance.

Also available from records were contract sums paid for cleaning, volume of refinable oil and wax lost in tank bottoms, and overhead costs. A summation of these figures gave a cost ranging from $5000 to $8000 per cleaning for an 80,000-bbl tank, including at least $2000 in marketable oil and wax lost in the bottoms. In many instances the value of hydrocarbons lost in bottoms was considerably in excess of this amount, running as high as $6000 in some cases.

Other factors of varying economic importance were:

1. *The value of lost storage while a tank was out of service for cleaning (about 2 per cent of its working time).*
2. *Gradual decline in volumetric efficiency of the tanks as the BS&W level was raised.*
3. *Accelerated corrosion of tank bottoms caused by corrosion products in a connate water environment.*
4. *Disruption of routine dispatching procedures because of interrupted tank service.*
5. *Difficulty with or inaccuracy of hand gaging as a result of bottom sediment.*

Elimination of any of these factors would mean an appreciable saving, although none could be rigidly evaluated.

The cost per 25-hp mixer was about $4000, including installation, power line connections, and overhead. One mixer was recommended for installation on a tank having a capacity of 80,000 bbl or less, and 2 mixers were considered necessary on a tank larger than 80,000 bbl. Therefore the cost of equipping 80,000- and 122,000-bbl tanks as recommended would require

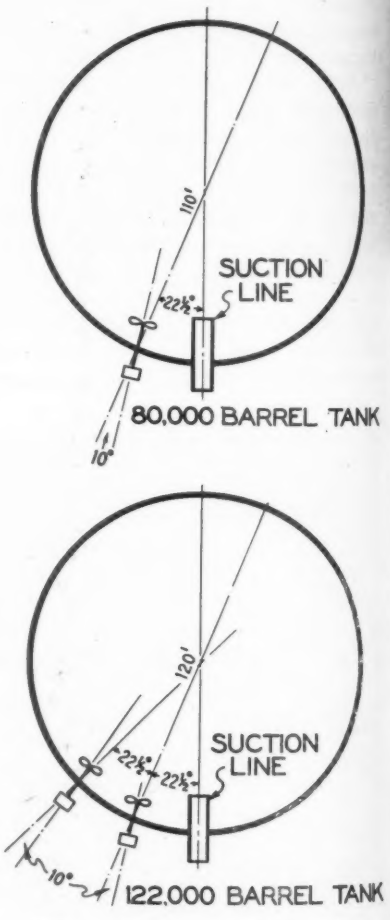

FIG. 1. Placement of tank mixers.

†Presented at the ASME Petroleum Mechanical Engineering Conference, Los Angeles California, 1954.

*Shell Pipe Line Corporation, Houston, Texas.

[1]Taken herein to mean the commingling of of different types and gravities of crude oil within a tank and thus the prevention of in-tank stratification.

[2]Taken herein to mean formation materials, corrosion products, free and suspended water, and all other materials foreign to crude oil. Tank bottoms or sediment is taken to mean these as well as settled oil and wax.

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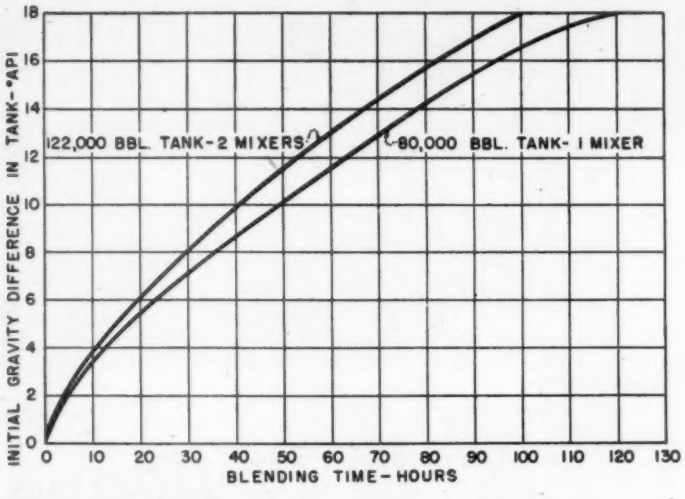


FIG. 2. Required blending time for full tanks of crude oil.

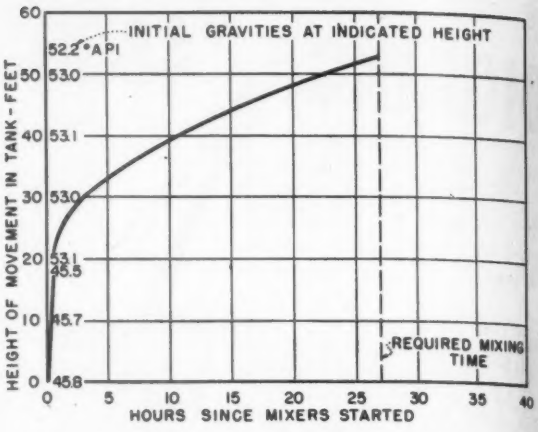


FIG. 3. Ascent of circulation in 122,000 bbl tank.

initial expenditures of $4000 and $8000, respectively. Annual operation and maintenance cost was estimated to be $250 per mixer.

On the basis of tank-cleaning costs alone, an 80,000-bbl tank can be provided with a mixer which will be paid for (before taxes) in 4 or 5 years. Intangible benefits, such as those mentioned previously, make the investment still more attractive.

The loss of refinable oil and wax in bottoms is usually greater for a larger tank. One company has four 122,000-bbl tanks that have been in West Texas crude service for 5 years. They will soon be taken out of service for removal of 29,000 bbl of sediment containing about 40 per cent hydrocarbons. The cost of this cleaning job will be at least $43,000, including labor, overhead, and the value of the oil lost. After cleaning, these tanks will be equipped with mixers. At a cost of almost $11,000 per tank every 5 years for cleaning, 2 mixers will be paid for by the elimination of 1 cleaning job. The high sediment accumulation rate in these tanks is the result of infrequent working.

An inspection of tank bottoms accumulation data for the past several years showed that sediment built up around the tank periphery to heights of four or five feet in about four years, and then accumulated at a much slower rate. The decline in rate of accumulation may be explained by the use of stationary filling-suction lines that enter just above the tank floor and generate a sweeping action at the center of the tank bottom area. At this stage of sedimentation large volumes of this sediment will on occasion break loose and move into the pipe line system.

After the accumulation reached five feet, sediment was transported to the refinery at approximately the same rate at which it was received at pipe line terminals. With swing suction lines the buildup may be more uniform, and may reach greater depths without regular movement of BS&W to the pipe line; however, if the swing line is accidentally lowered to the BS&W level, serious consequences may result.

The factors of increased pump and pump seal wear, and power required to transport BS&W were found to be inconsequential after sampling and analysis of the crude streams and tank bottoms had been completed. This analysis is discussed in some detail later. Possible increased vapor loss because of agitation was an intangible item. It was considered to be insignificant, however, and this conclusion later proved true.

Refiners' Viewpoint

In order to evaluate the effect on refinery operations of installing mixers in pipe line tanks, the questions to be answered were:

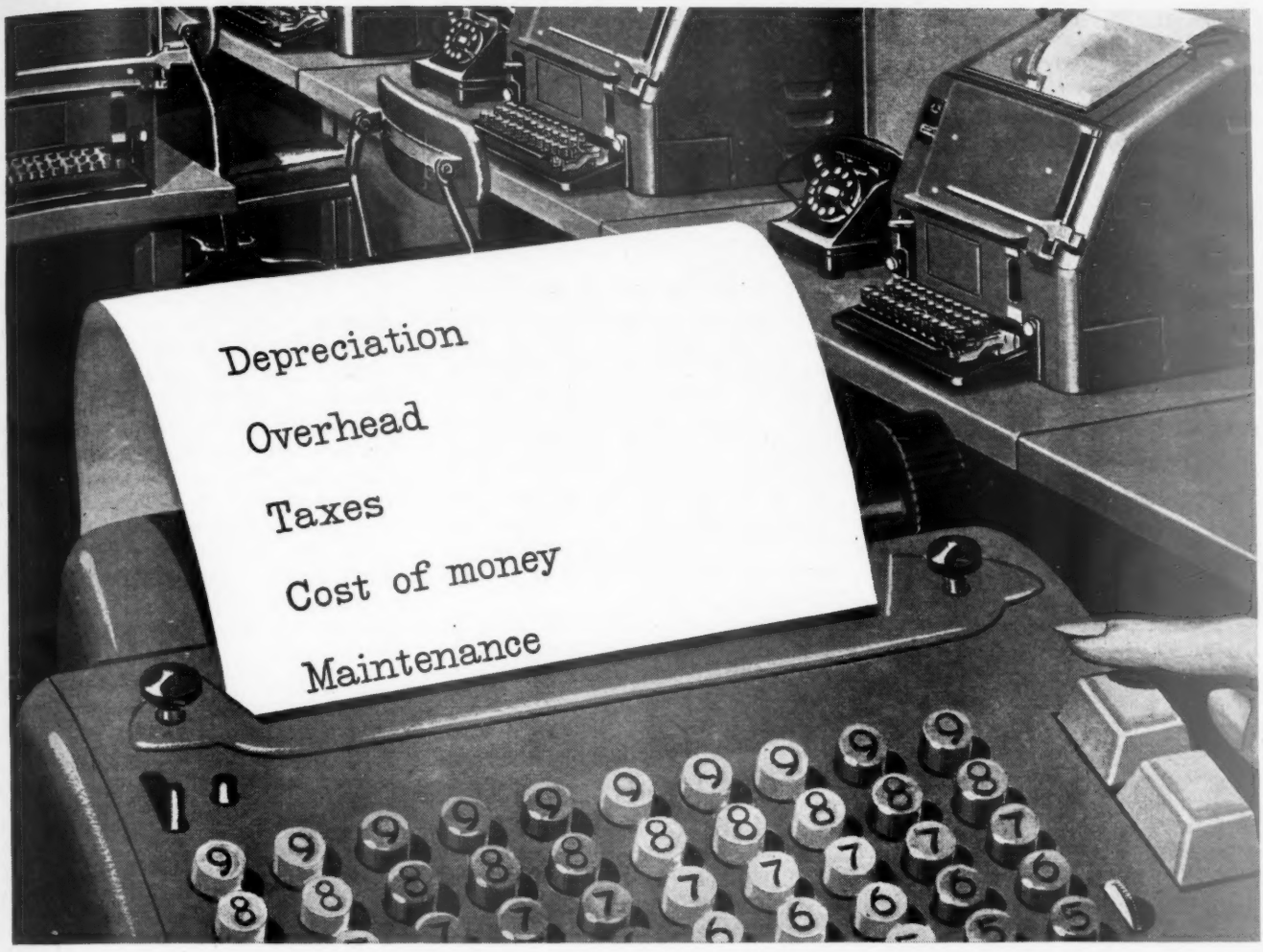
1. What difficulty had been experienced because of non-uniform crude composition and receipt of abnormally high percentages of BS&W.
2. What percentage of foreign materials carried by the crude stream was settling in pipe line tanks? What volumes were involved, and what was the composition?
3. How would receipt of additional sediment effect refinery tank bottoms accumulation and tubular equipment.

No exact cost was assignable to distilling throughput losses as a result of crude oil gravity fluctuations; however, reductions of as much as 3700 bbl in 8 hours had been experienced, and smaller losses were fairly common. BS&W "slugs" on reaching the refinery had caused peak desalter loads considerably above normal, and in some cases necessitated long settling time for the contaminated crude prior to processing. Elimination of these two disturbing factors would mean an appreciable saving, although neither could be rigidly evaluated.

To determine the amount and effect of increased BS&W receipts, an extensive sampling program was necessary. Crude oil tenders upstream and downstream from pipe line and refinery tank farms were analyzed, as were tank bottoms. The bottoms showed a volumetric breakdown approximately as follows: Foreign solids, 1 to 2 per cent; water, 30 to 60 per cent; oil and wax, 40 to 70 per cent. The solids consisted of about 10 per cent fine quartz sand, 50 per cent ferric oxide, 40 per cent gypsum, calcite, and other formation materials.

From these analyses it was calculated that about 1,236,000 lb of foreign solids were present in the BS&W delivered yearly via pipe line to one refinery tank farm. Of this, 50,400 lb, or 4 per cent, settled in refinery tankage, and the remainder was presumably removed by the desalting process. Analysis also showed that pipe line tanks immediately upstream from the refinery retained a similar percentage when deposition was low. As sediment built up, deposition rate decreased to the point where practically all sediment received was being transported and delivered to the refining units.

Based on observed annual average sedimentation in pipe line tanks and the volume of oil transported, the increased BS&W reaching refineries, as shown by "grindouts," was expected to be 0.04 per cent. This conclusion was substantiated by comparison of data from two tank farms, neither of which was equipped with mixers. The farms received crude of similar kind and content; one received oil almost entirely from mixed storage and the other almost entirely from unmixed storage. There was no discernible difference in bottoms accumulation rate. It was con-



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cluded that, in tanks receiving crude containing normal percentages of suspended bottoms, deposition rate is chiefly a function of settling time.

Further verification was obtained by consultation with a refiner who uses mixers in all crude tanks. No unusual difficulty with tube fouling had been encountered at this plant.

These preliminary studies indicated that both pipe line and refinery operations would be benefitted by the use of mixers and led to the decision that mixers would be installed in all new tanks at the time of construction and in older tanks when taken out of service for cleaning or repair.

Mixer Operating Tests

Installation. Mixers are currently installed as shown in Fig. 1; one side-entering unit in 80,000-bbl tanks and 2 mixers in 122,000-bbl tanks. The mixer shaft is inserted horizontally about 36 in. above the tank floor. All installations are of standard design with 26-in. diameter marine-type propellers of cast iron or stainless steel which project into the tank about 32 in. Motors are 25-hp, 1740-rpm, with a gear for reducing propeller speed to 420 rpm. Some installations are equipped with conventional shaft packing and some with mechanical seals. At this writing, experience is inadequate to express a preference for either the packing or the seal installation. As more operating data become available, the number, location, entry angle, and mechanical details may be changed if worthwhile improvements in operation or economics are indicated.

The 80,000-bbl tanks used in these tests are 110 ft in diameter and 48 ft high; the 122,000-bbl tanks are 120 ft in diameter and 54 ft high. All tanks were equipped with floating roofs.

Scope of Tests. These tests were designed to determine the most satisfactory operating procedure for achieving uniform blends prior to starting deliveries from storage tanks. The work of others[3] has shown that for frequently worked tanks, as little as 24 hours mixer operation per month prevents bottoms accumulation. It was therefore reasonably certain that minor adjustments in blending operations would serve both purposes. Further, the effectiveness with respect to sedimentation only would require several months of observation.

Six 80,000 and six 122,000-bbl tanks were utilized for the tests, and results were obtained on 4 grades of crude oil. Blended batch gravities at test temperatures ranged from 32 to 50 deg API, and in-tank gravity differences from 0.1 to 15.4 deg API. The viscosities of the blended batches varied from 34 to 80 SUS at test temperatures. Physical properties of batch component before blending varied from 22 to 53 deg API and from 30 to 350 SUS at test temperatures.

Included were tests on full tanks, on tanks being filled, and on tanks being emptied. The widest possible latitude was given the tests in order to make them of benefit in meeting present as well as future blending requirements. The limitations were those imposed by existing conditions, but the test results on full tanks of oil can be extrapolated as long as the extrapolation is confined to 80,000 and 122,000-bbl tanks with 1 and 2 mixers respectively.

In these tests, a satisfactory blend was considered to be one in which the oil delivered from a tank varied in gravity not more than one degree API. This standard was in conformance with refinery process requirements. Tanks containing oil of less variation than one degree were blended for the purpose of obtaining test data points.

These tests were intended to solve an operating problem. No attempt whatever was made to investigate basic mixing theory.

[3]Halpine, J. H., "How Mechanical Agitators Rid Tanks of Sediment," *World Oil*, July 1953, p220H.

Discussion

Initial tests were conducted by agitating while the tank was being emptied. Prior to the test, gravity samples were obtained at 6-ft intervals in the tank from top to bottom. The mixers were started when the tank was opened to suction and operated until the tank was low-gauged. In-tank gravity differences were compared with line samples taken at 15-min intervals for the first 2 hours and hourly for the remainder of the tests.

It was quickly established that this method did not achieve blending. Where an appreciable gravity difference existed in the tank, the batch in the pipe line showed a similar, though somewhat decreased gradient. This method might be acceptable if suction rate is very low, but with high flow rates, little blending is accomplished. Another disadvantage is the tendency to move the major portion of resuspended tank bottoms in the initial part of the tender.

Determination of the effectivness of mixers in blending full tanks of oil was then undertaken. Samples were obtained at six-foot intervals in the tank from top to bottom and the indicated gravity and temperature of each sample determined. Tests were made for suspended BS&W on top, middle, and bottom samples. Mixing was started and continued until there was agitation at the top of the tank at which time top, middle, and bottom gravity and BS&W samples were again taken.

It was found that movement traveled upward in uniform oil at a nearly constant rate, reaching the top of a 48-ft tank in 15 to 30 min after starting the mixers. If the full tank contained 2 layers, movement reached the interface in a matter of minutes, but proceeded up through the second layer slowly. The ascent of circulation was measured by lowering a weight on a gauge tape to the point where movement could be detected. The height of circulation was determined within one foot by this means. By successive measurements, the time to achieve full circulation could be predicted by plotting the rate of ascent. It was concluded from these measurements that a gravity change causes deflection of the upward velocity vector toward a horizontal plane, thereby decreasing the mixing rate. Fig. 3 illustrates this point.

Samples were taken from just below the top point of movement to the tank bottom. These showed that, at any time during the test, mixing was complete in the moving portion of oil from one foot below the static oil to the tank floor. It was concluded, therefore, that when movement reached the top of the oil level, a uniform blend would be achieved. This was verified by all tests.

TABLE 1. Summary of results from tests on full 80,000-bbl tanks.

Test No.	Avg. vix. at test temp. SUS	Avg. API gravity at test temp.	Initial gravity difference in Tank—deg API	Final gravity difference in Tank—deg API	Required mixing time
7	58.0	32.0	0.2	0	11 min
19	49.0	38.3	0.3	0	17 min
10	43.0	39.2	0.3	0	30 min
22	50.0	37.0	0.1	0	50 min
12	47.0	36.2	0.5	0.1	1.1 hrs
18	46.0	36.7	2.1	0.1	3.5 hrs
6	39.5	42.0	2.9	0.1	9.0 hrs
21	73.0	32.0	15.4	0.2	92.0 hrs

TABLE 2. Summary of results from tests on full 122,000-bbl tanks.

Test No.	Avg. vis at test temp. SUS	Avg. API gravity at test temp.	Initial gravity difference in Tank—deg API	Final gravity difference in Tank—deg API	Required mixing time
11	38.0	42.8	0.3	0	13 min
17	50.0	34.9	0.3	0	30 min
14	32.0	47.1	0.7	0.1	48 min
15	35.5	46.2	1.3	0.5	1.7 hrs
8	36.0	37.2	1.1	0	1.8 hrs
16	35.4	44.9	4.0	1.2	10 5 hrs
9	34.0	50.3	7.6	0.8	27.0 hrs
20	37.0	44.4	7.8	0.4	29.0 hrs

XUM

The maximum variation in gravity found in the circulating portion of oil was less than one degree API; in a blended tank it was 1.2 deg. Because of the way mixing occurs, a partially blended tank is one that is still stratified, but with the interface at a higher level.

In all cases, the top layer of a stratified tank was found to be of higher API gravity (lighter) than the lower layer. When the filling sequence would suggest light oil in the lower strata, natural gravitational force differences apparently caused the oil to mix without agitation.

To determine approximate velocities of movement when the mixing level moved to the top of a full tank, 7 by 24-in. paddles were inserted in 3 hatches on an arm extending down 3 ft below the underside of the roof and at a point close to the tank wall. The paddle arm swung about a pivot pin set at a length ratio of 6:1. Spring scales attached to the paddle arm measured 6 times the force exerted on the paddle blade. This arrangement allowed an approximate calculation of oil velocity and direction of movement.

It was found that the oil moved at fluctuating velocities, perpendicular to the paddle blade of .02 to about 1.0 ft per second. Eddy-type movement was almost always present. From similar observations on partially filled tanks, average velocity was found to increase toward the tank bottom. When looking down on the tank, movement was clockwise.

After shutting off the mixers, measurement was continued to determine how long the oil continued to circulate. Low-viscosity, high gravity oils continued in motion for several hours (up to 18) after the mixers were stopped but high-viscosity, low-gravity oils came to rest in a matter of 2 or 3 hours. This movement did not affect oil level gauging after mixers had been off for 2 hours, provided gauging was done through a well extending to the tank bottom. Movement did have an appreciable effect on measurements taken through a roof hatch, however. It is therefore recommended that gauge wells be installed in all tanks equipped with mixers.

The results of tests on full tanks are shown in Fig. 2 and Tables 1 and 2. The best correlation found was the blending time as a function of initial API gravity difference. These data plotted essentially a straight line on logarithmic paper, and lines were fitted to such a plot by the method of least squares. Values were taken from the lines thus determined to derive the curves of Fig. 2. The correlation shown is considered ideal because API gravity can readily be determined in the field.

As stratification of crude oil results in deflection of the upward velocity vector of the lower layer of circulating oil, the position of this interface in the tank affects mixing rate. At any given initial gravity difference, a lower interface results in longer mixing time. Gravity difference, however, has far more effect on mixing rate as shown by the correlation of Fig. 2. The effect of viscosity, in the range investigated, is not significant.

The periods of time required to eliminate larger gravity differences were found to be too long to be practical when blending full tanks. One test on an 80,000-bbl tank had been made by intentionally filling it to produce about 15 deg API gravity difference. The blending required more than 90 hours.

To obtain a comparison between this method and the effectiveness of operating the mixers while filling, the same oils were put in the tank, but the tank was half-filled with light oil, and mixing was started as the heavier oil was pumped in. Filling and mixing continued for 25 hours, at the end of which time the test tank was uniformly blended. Similar tests gave equivalent results. By using this method, blending time can become a function of filling time rather than gravity difference. These tests show conclusively that mixer operation while filling the tank is the most successful blending procedure.

Subsequent tests of the same nature were attempted by first determining the tank gravity and comparing it with the gravity of the incoming stream. When the API gravity of the incoming stream is equal to or higher than that of the oil in the tank, agitation is unnecessary in most cases. From an operating view, however, it is often impossible to predict how line gravity fluctuations will behave in tanks. To avoid possible errors it was concluded that mixers should be operated each time a tank is filled. As the propeller discharge stream reaches upward to an estimated height of 20 ft, the blending operation need not be started until that gauge has been reached.

Blending crude oils while the tank is filled places a maximum limit on allowable mixing time. If a tank is to be blended by the time it has been filled, mixing time cannot exceed filling time. It is believed that mixers provided as herein described can accomplish this objective. The gravity difference of almost 16 deg API between the oil in the tank and that in the filling line, which existed in the previously mentioned test, is greater than is normally encountered. As long as required mixing time is not greater than filling time, expenditures for additional mixing capacity cannot be justified.

Bottom thievings were taken before and after tests. These measurements were inconclusive with respect to reducing deposits, but showed that bottoms were shifted from side to side by the oil circulation. Suspended BS&W usually increased about 0.1 per cent after agitation and was uniformly distributed in the oil from top to bottom, thus showing a pickup. Bottoms accumulation in the tanks used for tests varied from immeasurably small amounts to 4 or 5 in. The one exception was an infrequently-worked tank which had a 7-in. deposit. At the time tests were completed, mixers had been in service about one month, and the tanks had been in service for several months.

Suggested Operating Procedure

These tests resulted in the following suggestions for effective blending of crude oils:

1. Operating mixers while filling the tank is better adapted to most needs as it consumes no storage time. This method is suggested for use where possible. At each filling, mixing should be started when the tank reaches a gage of 20 ft and continued until the tank is full. After filling, a check should be made for oil circulation and operation of mixers continued until movement is present at the top. Experience may show that in most cases, effective blending can be accomplished by delaying the start of mixing until the tank reaches a higher gage.

2. When it is not possible to operate mixers while filling, the full tank should be blended as follows:

   The top, middle, and bottom gravities should be determined and the maximum differences noted. Mixing time necessary should be found for that API gravity difference by referring to a working curve similar to Fig. 2. Mixers should be operated the indicated length of time and, before stopping them, a check should be made for oil movement at the top of the tank. If movement is present at the top, mixing is complete.

   The final gage should not be made until little or no movement is present in the gage well. A waiting period of about two hours is required.

   The full tank should be agitated for an hour while on suction. This should resuspend settled bottoms.

At this writing these suggestions have been used by one company about eight months, and they have been entirely adequate for blending. They have not been in effect a sufficient length of time to determine their adequacy in preventing sediment accumulation, but it appears that this problem, too, has become one of the past. * * *

XUM

Depending on operating conditions, removable cups and screens on air cleaners need attention every 5 to 60 hours of operation. Entire air cleaner should be removed and cleaned at least once per year.

Regular lubrication means longer machine life. Routine lubrication, part of preventive maintenance program, has been found to have a direct effect on profits through extension of machinery life.

Modern Equipment Maintenance
One of a Series

Despite improved design, better lubricants, advanced repair facilities, keeping tractors and heavy equipment on the job requires regular

Preventive Maintenance Programs

D. R. LAMMERS

PIPELINERS, harrassed as they often are by bad weather, rough terrain and oppressive completion deadlines, are especially sensitive to the importance of keeping their machinery investment working for them when the chips are down.

Emphasis on reliability in machinery marks the purchasing practices of the pipeliner, but without exception the successful members of the industry also buy with an eye to easy, simple maintenance and follow it up, when possible, by employment of people with the integrity to practice accepted maintenance procedures outlined by the manufacturers.

This year marks the 50th anniversary of the crawler tractor. A half century ago Benjamin Holt manufactured the first commercially successful track-type tractor, and in the ensuing two score and ten years, the machine has developed rapidly until it is the prime tool in a variety of industries where pulling and lifting are of basic consideration.

Certainly the pipelayer mounted on the crawler tractor has become as indigent to the industry as any one piece of equipment. Its acceptance as the best tool for the job has come as a result of research, engineering and improved manufacturing technique. But there is a less often told story of how good maintenance has added to the profit-making potential of any tractor, whether it be owned by pipeliner or potato farmer.

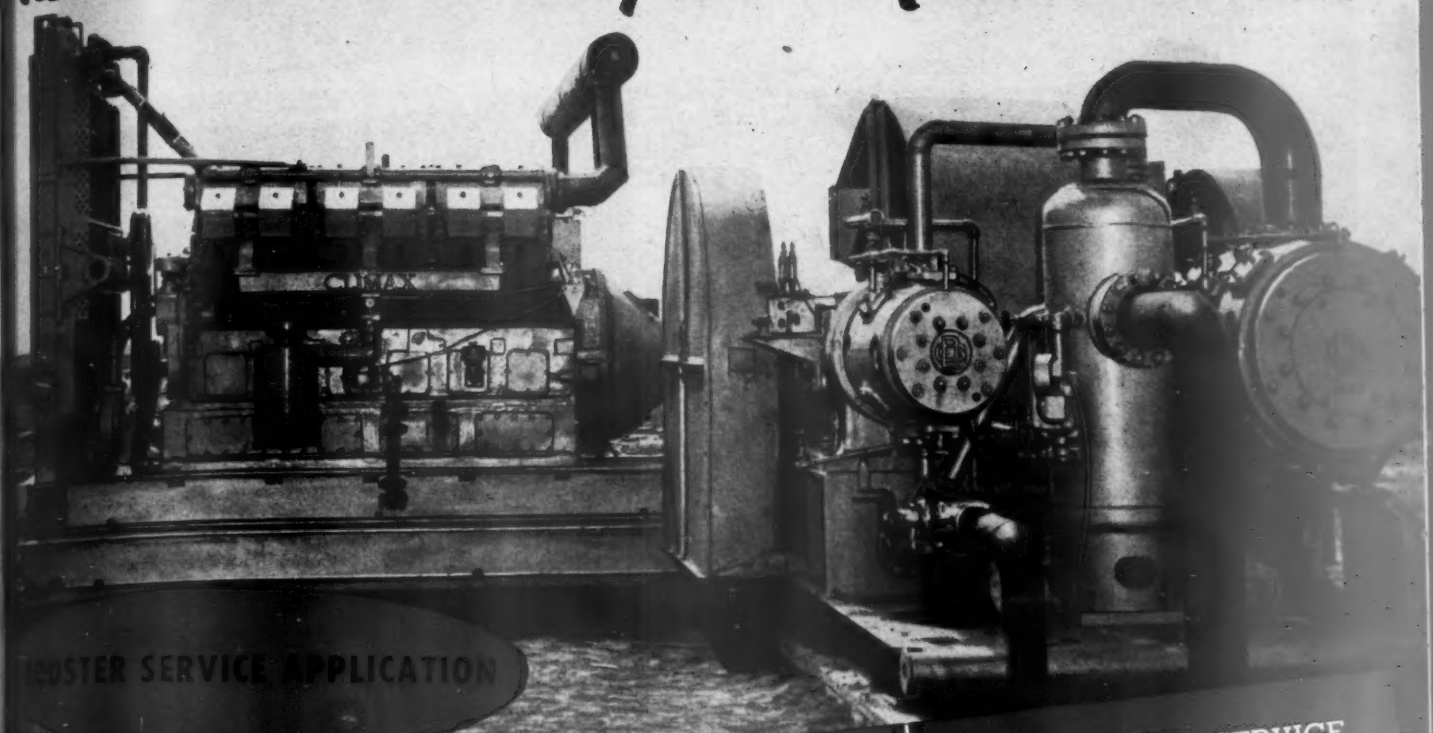
The manufacturer has wherever possible, enclosed the parts or used ingenious seals to protect them from their arch enemy — dirt. He has made use of new metals and heat treating processes to produce tougher and more wear resistant members. He has promoted, in cooperation with the oil industry, the use of new lubricants to

EXCLUSIVE

ever increase the performance life of his product. He has rearranged the operating controls and provided other means to reduce operator fatigue. He supplies complete instructions covering the necessary servicing. The manufacturer has, by numerous developments, greatly extended the operating periods between overhauls. He has helped reduce operating costs by producing a better, more easily maintained product.

Many selling dealers have established at considerable expense, extensive service facilities, staffed with highly skilled service personnel and equipped with the most modern tools and fixtures. In addition, he has available for immediate delivery almost any required repair part. His establishment can render quick efficient service in the shop or on the job site in the field in event of breakdown. The dealer has promoted educational programs for the owner's operating per-

tailor made to fit your requirements...



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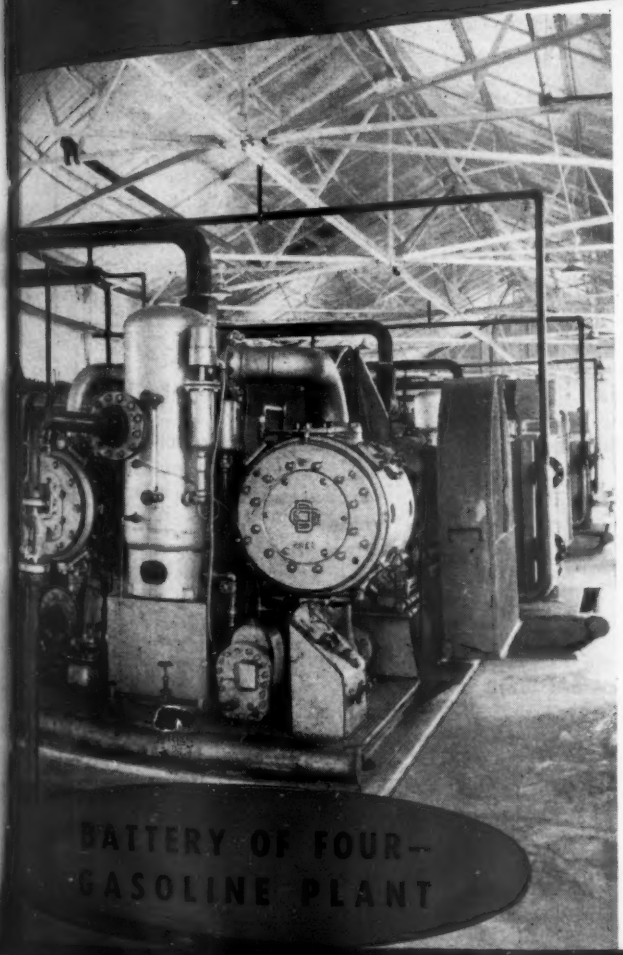

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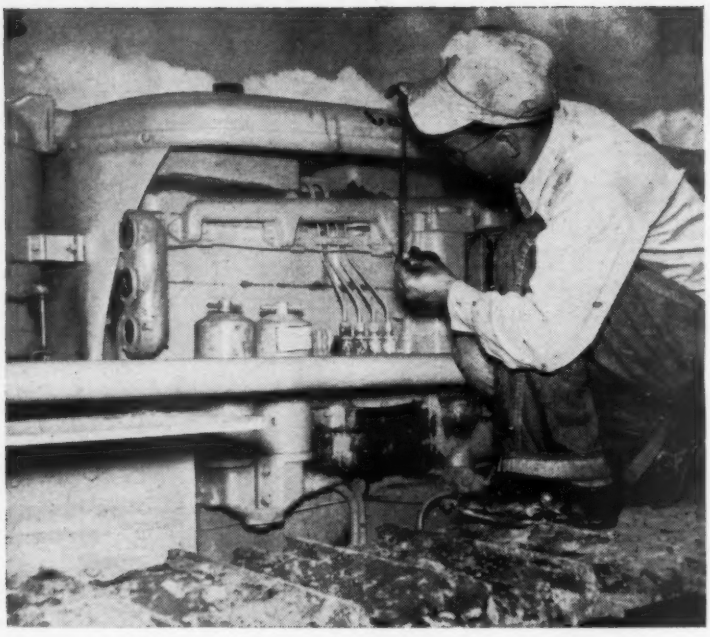
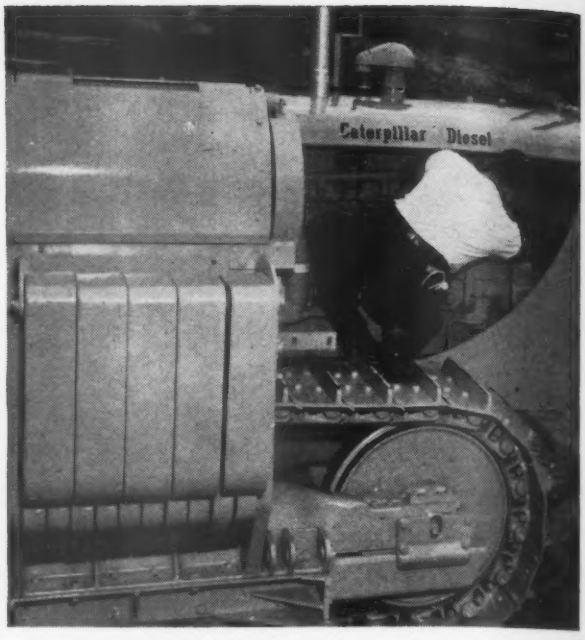
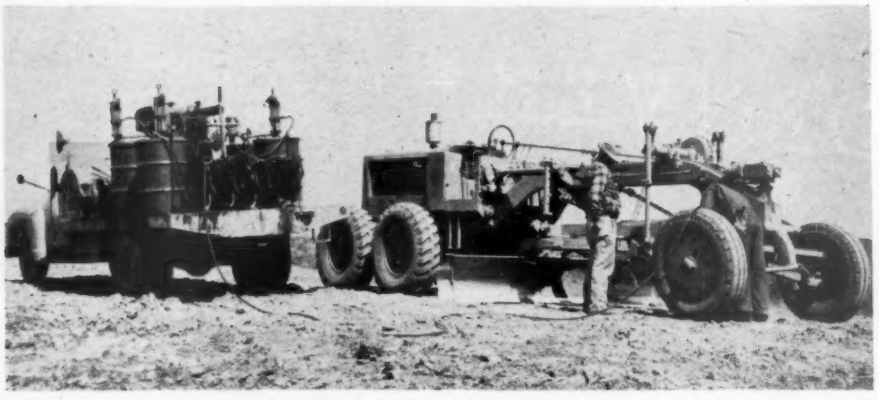


Crankcase oil level as indicated on dipstick should be checked every 10 hours while engine is running. Draining and refilling should be scheduled every 240 hours or as service program directs.



One of the most important day-to-day checks is tension and condition of fan belts. Loose belts slip, cause unnecessary wear, could allow engine to overheat.



Service on job is important part of preventive maintenance. Service unit such as pictured here can be part of owner's regular equipment or can be rented or leased.

sonnel and through these, has reduced and in many instances, prevented expensive delays.

Periodic Maintenance Required

Despite the many improvements in construction, the advanced facilities for repair, and the developments in materials and lubricants, these modern machines still require carefully planned periodic maintenance.

The owner of a track-type tractor is directly concerned about its operating costs, for this figure has a major effect on his balance sheet for the operation — profit or loss. All but one of the items that make up the costs are fairly well defined: Purchase price, depreciation, parts replacement or repair due to normal wear, fuel and lubricants, and operating labor. The variable figure that cannot be estimated nor sometimes even computed is the cost of premature wear or damage to one or several associated parts because of neglect. In addition to the cost of the repairs, we must add the loss in production because of down time.

The improvements that have been designed and built into the tractor were incorporated by the manufacturer because he believed that eventual usage would place the tractor under conditions far from the ideal, that the operator may be inexperienced, and that maintenance people may handle their work — adjustments and lubrication — on an "if and when" basis. Someday, such improvements may produce a permanently lubricated and adjusted machine. Today, even with the 50 years advancement, some degree of consideration on the part of the operator and maintenance man must be received if the full potential life built into the tractor is to be realized.

Maintenance is in four separate areas:

1. **Adjustments to compensate for normal wear.**
2. **Adequate lubrication of the working parts.**
3. **A general tightening of shock-loosened bolts, nuts and cap-screws and minor parts replacement.**
4. **Prevention of the entrance of dirt, abrasives or other foreign materials into the working parts.**

Continuous attention must be directed to the supply and use of recommended lubricants. There are air cleaners and breathers to be inspected and cleaned. There are oil levels and pressure gauges to check, compartments to drain and numerous incidental or miscellaneous jobs to ac-

The Author

D. R. Lammers is service manager for Caterpillar Tractor Company. He joined the company immediately following four years of World War II service as an officer in the United States Navy. His experience at Caterpillar includes employment in the service development division after which he was named eastern division service manager. His appointment as service manager was in 1953. Lammers is a graduate of Sacramento College at Sacramento, California, where he obtained his degree in mechanical engineering. Before completing his college work, he had been employed in California in the service departments of Caterpillar distributors at Sacramento and San Leandro.

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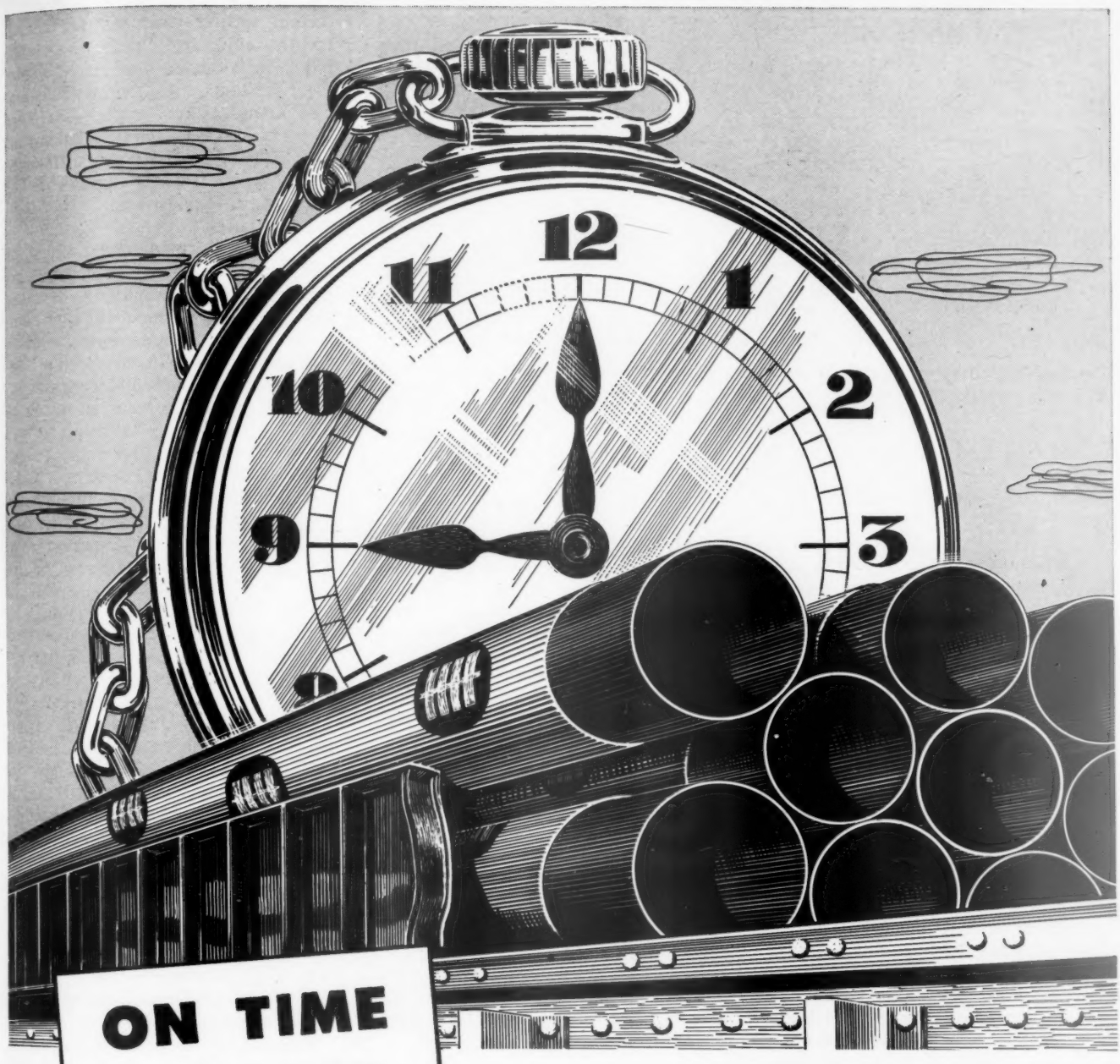

ON TIME SERVICE

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complish such as cleaning the trash from in front of a radiator or removing frozen mud from track carrier rollers.

Maintenance Scheduling

The manufacturer, through experience and from suggestions from owners, has found that 10 hour intervals are the most convenient for accomplishing the maintenance operations on the equipment. For that reason, operator's instruction books recommend inspection and lubrication periods of 10, 20, 60, 120, or 240 hours to allow easy maintenance scheduling. Gear compartments, for example, should be drained and refilled at 900 hour periods, or about every 2 months on a 20-hour day, 5-day per week working schedule.

Looking through the details of the maintenance recommendations, we begin to realize the size of the requirement. Multiply this by the number of units on the job and the responsibility becomes enormous. Who, when, and with what will we do the fueling, lubrication, adjustments, repair, or minor replacements? All of the individual requirements must be faithfully and properly accomplished for it is the grease fitting that was consistently missed, or the adjustment that never was made, that can quickly relegate an otherwise serviceable machine to the "dead line."

The apparent enormity of the job demands some method of organization or simplification, otherwise there is no assurance that 98 per cent, 70 per cent or even 25 per cent of the points that need greasing, adjusting, or cleaning will receive attention at the proper time.

"Boss Man" Needed

Any plan or program requires someone to direct it, that is, to be the "bossman." *One person to delegate and fix responsibility among others is the first step toward organization.* On the larger operations, the equipment superintendent may head up the maintenance section. He may direct that some of the minor tasks be regularly accomplished by the machine operators. He may provide a crew of people for the periodic on or off shift oil changes and greasing. He may contract with a machine dealer to provide a trained serviceman who is responsible for all day-to-day or running adjustments and regular machine inspection.

The owner of a few tractors should apply the same reasoning in establishing his program. The only difference is the number of responsibilities assigned to an individual. His operators may have to accomplish all the lubrication and running adjustments while his mechanic may handle all the oil changes, in addition to making minor parts replacements and periodic inspections.

Regardless of the number of tractors on the job, someone must be available to schedule, supervise and inspect the entire maintenance operation.

Personnel and Facilities

The preceding discussion reveals the program's second requirement — *qualified and dependable people.* In years past perhaps only dependable people were needed, but with today's powerful precisely-built tractors, the maintenance personnel must be qualified as well as dependable. Operators, fuel and lubricant handlers, mechanics, and maintenance superintendents must know the how, when and why of maintenance. Unfortunately, the number of these individuals is not increasing. One may find plenty of "floaters" but not always the conscientious regular.

The third requirement of an organized maintenance program is *facilities* —a place to work and tools with which to work. Supplied with each new machine is a package of tools consisting generally of hand grease guns, oil cans, volume oil dispensers, and certain special wrenches for conveniently adjusting clutches or other parts. In addition, there is an assortment of tools for general tightening. The manufacturer supplies the basic essentials of the facility requirement, and with these a good job of maintenance can be accomplished. This has been often demonstrated by the individual owner.

If tractors are operating singly or away from any base maintenance organization, it is important that the maintenance equipment be kept complete and in good operating condition and accessible to the tractor, preferably on the machine. Each grease gun or pump should contain an adequate supply of the *proper* lubricant. It will be found virtually impossible to encourage an operator to do the lubricating, make minor running adjustments or general tightening if his tool equipment is not available or in good operating condition. Improper equipment is almost certain to result in improper maintenance.

We now have fixed the responsibility for maintenance on a qualified administrator who has written and given specific instructions and latitudes of duties and responsibilities to a group of capable people, and he has provided them with the time and the materials with which to accomplish their assignments. There remains one other problem—that is the elimination of guesswork about what is to be done, who is to do and when. Some workable system of records seems to be the answer.

The two fundamental advantages of record are obvious:

1. They fix responsibility.

2. They eliminate failures of the human memory.

These records need not be elaborate. In fact, the more simple they are, the greater are the chances that they will be conscientiously kept up-to-date and not filled in just prior to a routine check.

The "apparent enormity" of the maintenance requirements can indeed be reduced to a very workable routine. It is fundamentally a matter of:

(1) who has the primary responsibility?

(2) why and how does the job have to be done?

(3) what tools must be provided to quickly and accurately accomplish the work? and

(4) what assurance is there that the job was completed at the proper time?

Ask yourself these four questions, and develop the answers with your own organization. Your own answers will write a story of increased productivity and economy brought about through fewer breakdowns, lowered repair, and operating costs. * * *

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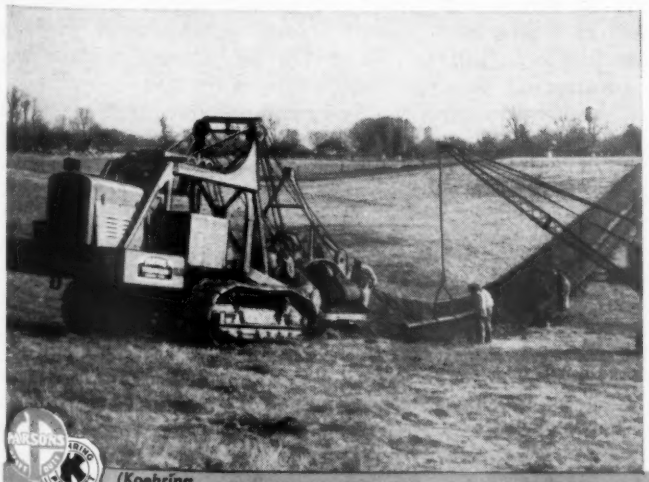

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P 615.323

WHY BEND PIPE?†

Pipe bends can be reduced, perhaps 50 per cent, resulting in:

- **fewer bending, ditching, and laying problems**
- **greater progress**
- **minimum pressure drops**
- **reduced scrap pipe**
- **reduced reclaimed pipe straightening**

J. C. STIRLING*

THE main purpose of this paper "Why Bend Pipe?" is to arouse fruitful thought and discussion on a long-overlooked subject. The purpose is not to criticize the past methods of construction companies or to run the present manufacturers of pipe-bending equipment out of business! The chief aim of this study is to provoke us all to take a new look at a pipe-laying practice that has prevailed for nearly 100 years.

The thesis, or theme, of this paper is simply this: We can lay future pipe lines with fewer bends than we now use or have used in the past. We can never eliminate all bends, but we can minimize them; and many authorities claim that the best pipe line is the straightest one, both horizontally and vertically.

Research for this paper has involved information from printed material, interviews, and letters from about 25 experienced men in the field who represent as many different companies. The response has been overwhelming. Facts and opinions came from all 18 members of our subcommittee and from half a dozen companies that manufacture pipe-bending equipment; other material came from specialists in the pipe line construction business and from consultants with an experience rich enough to retire them.

Some did not wish to be quoted; others didn't mind. Some spoke only as individuals; others, for their companies as well. Some reported on one side of the problem only; others, on both sides. The collation of all data received should represent a fair synthesis and should incriminate no one. And perhaps from the composite information we can justly draw some valuable conclusions. Therefore, to present honestly all the facts and opinions, analyze the subject by the old Socratic method of questions and answers.

†Presented at 34th annual API meeting, Division of Transportation Pipe Line Symposium, Chicago, 1954.

*Service Pipe Line Company, Tulsa, Oklahoma.

20 Questions and Answers

Query 1. Is the elimination of all pipe bends advocated?

Answers. No. We can never reduce the normal number of weld fittings installed in the line at pump stations, nor can we eliminate bends in the pipe completely. But bends are used in many places where they are unnecessary. These we can certainly reduce.

Query 2. Does geographc location (topography) affect the number of bends?

Answers. Yes. Irregularities in the topography increases the number of bends required; the terrain of West Virginia, for example, is different from that of the prairie states. Surely no one believes that the Trans Mountain pipe pipe line could have been laid without any bends. But why bend pipe unnecessarily?

Query 3. How do surveying and selecting a route affect pipe-bending?

Answers. They are first considerations and therefore of prime importance. Good right-of-waying, before the ditching operation, takes care of many difficulties in terrain that cause abrupt over bends or sag bends in the line. This applies especially to the approaches to rivers, creeks, and draws. It is possible to construct a pipe line over any given route just as a railroad or highway is constructed. It is perfectly logical that horizontal and vertical curves can be made by stressing the pipe safely within its limits of yield strength. It is physically possible, if not wholly practicable, to design and construct a pipe line free of all permanent bends in the pipe itself.

Query 4. How does ditching affect the number of pipe bends?

Answers. Most companies can eliminate all vertical bends by grading the ditch properly and allowing the pipe to conform by virtue to its inherent elasticity. Contractors can eliminate unnecessary bending by operating the ditching machine at various depths. Fitting the pipe to ordinary ground contour can be accomplished by grading, widening, and curving the ditch. Avoiding abrupt changes in alignment or grade reduces bending to a minimum.

Query 5. Is it possible to lay pipe without making any bends in it?

Answers. Yes. Seven miles of 6-in. pipe were laid in 1946 near Lindsay, Oklahoma, over rolling terrain. The pipe weight was 17.02 and 14.97 lb per ft. A few abrupt ravines were spanned, but in general the ditch followed the natural contour of the ground. Very little extra excavation was made to produce long vertical curves rather than abrupt angular deflections. In 8 years no trouble whatever has occurred from this line.

Across much of the Arabian desert there are no railroads, roadways, ditches, farm drain tile, water courses, or other problems. Tapline constructed 450 miles of its 30- and 31-in. line in a beeline above the ground surface. Many of its sections are up to 5 miles long without even one bend in horizontal or vertical alignment. Steel in even high-carbon-content pipe in this line has proved that it can accommodate contraction or expansion through changes in temperature without any other provision for it.

A water line from Mulvane to El Dorado, in Kansas, has just been laid without any bending of the pipe. This line has 20 miles of 18-in. and 10 miles of 16-in. pipe with a wall thickness of 0.219-in. A few tube turns were used in places where it was impossible to force the pipe into the ditch. This line was laid along a railroad right-of-way that has several sharp curves; at one spot there is a deflection of about 60 ft in 400 linear ft. The ditching machine merely stayed a certain distance from the right-of-way fence, making a "very pretty curve."

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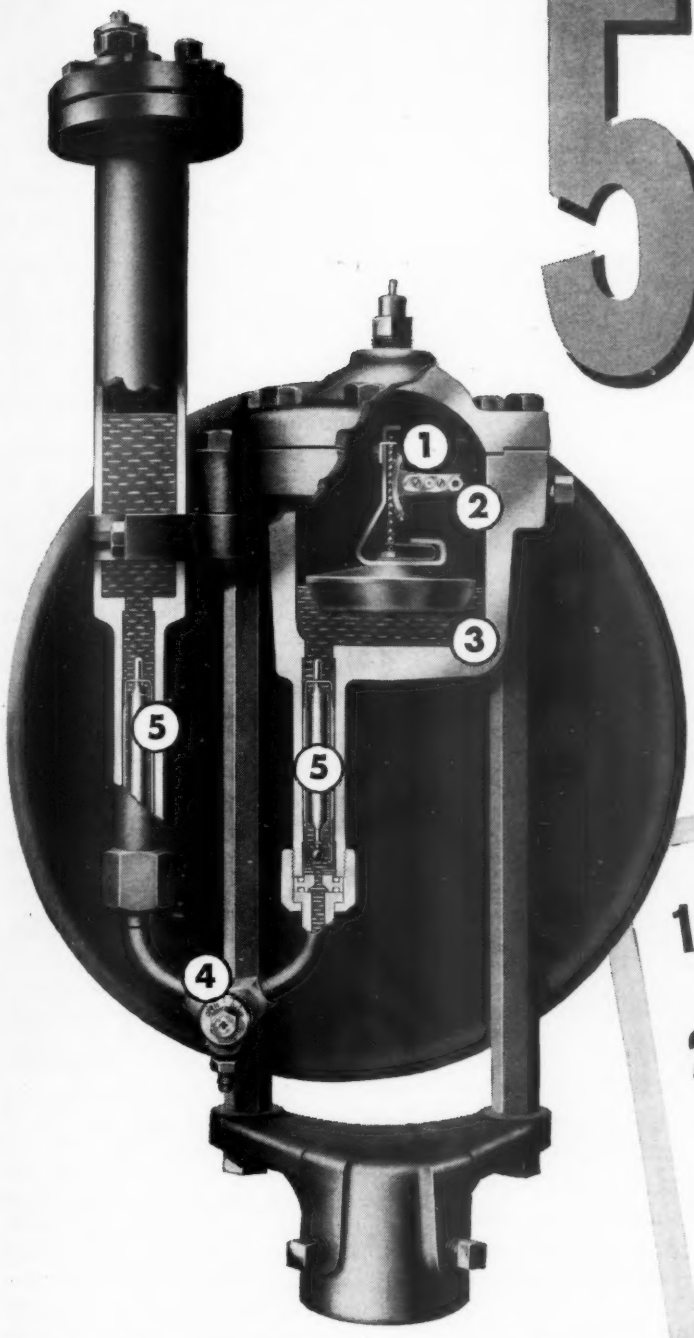

1 New Segmental Drive Assembly — stainless steel ball-type chain insures perfect alignment and friction-free travel of float.

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Query 6. What advantages are there in having no bends in the pipe?

Answers. (1) It eliminates the chance of improper bending by inexperienced crews or faulty equipment that cause the pipe to buckle or wrinkle. (2) It promotes the progress of construction because making bends is time-consuming and costly. It relieves men and machinery for other construction work. (3) It helps to keep pressure drop to a minimum. (4) It eliminates the extra time, expense, and damage in straightening the pipe if it is later reclaimed, as on temporary lines. (5) It reduces the amount of scrap pipe.

Query 7. It pipe-bending expensive?

Answers. A bending machine costs about $15,000 plus rental of the shoe, which is not for sale. Rental is approximately ½ cent per ft. In addition to the bending machine, the process generally requires a tractor, a foreman, 2 operators, and 5 men—a total of 7 or 8 men at about $26 per man each day, plus insurance.

Query 8. Can bends be made too sharp or too steep? Why?

Answers. Yes, and the over bends often come out of the ditch because of excessive slack in the line. With no abrupt bends in the line, any movement can follow the curvature of the ditch. Pipe has a natural tendency to roll itself into and fit the ditch when the line does not have excessive over bends and sags. When the ditch is dug in long vertical curves instead of providing for sharp over bends, the tendency of the pipe to come out of the ground during the heat of the summer is eliminated—provided there is no excess slack.

Query 9. For approaches to crossings (railroad and highway), should we grade more deeply and use no bends or grade less deeply and use abrupt bends?

Answers. Eliminate bends if at all practical. If excessive ditching is involved, then of course we favor the bends. But there seems no good reason for putting bends in the line merely because of a road crossing. To be sure, circumstances alter cases, and the decision here becomes a matter of choice.

Query 10. What is the difference in cost of these two methods?

Answers. Ordinarily the contractor does not charge for bends, but he does for digging extra-deep ditches. Very few contracts call for extra payment for extra-deep ditches at crossings. Most companies are usually willing to trade a little deeper ditch for an extra bend. Right-of-way problems in developed areas often cause the making of horizontal bends; when this is the case, the companies can set up specifications that will give free passage to scrapers, or go-devils.

A pipe line that requires considerably more grading naturally costs more money, and it may raise many objections from landowners. In some cases, buildings and other improvements might have to be moved, if bending the the pipe to miss these obstacles were not allowed. River crossings are, of course, much more expensive.

Pipe-bending can be reduced considerably through the choice of the route. Once a route has been established, bending pipe is less expensive than grading and ditching. The effect of bends on the performance of a pipe line is not sufficient to justify the added cost to eliminate the bends.

Query 11. Are factory bends advantageous, practical, and economical?

Answers. Since the present bending machines have been put on the market, factory bends have been practically eliminated on all cross-country pipe line construction. Both fast and economical, modern bending equipment does not materially decrease pipe-wall thickness on the outside nor increase it on the inside.

Although factory bends are much better than the old fire bends or wrinkle bends, our present method is much more economical. Factory bends are not only expensive, but also require two circumference welds when they are installed. And some bends are usually

First With Big Inch Smooth Bends . . . In Performance!

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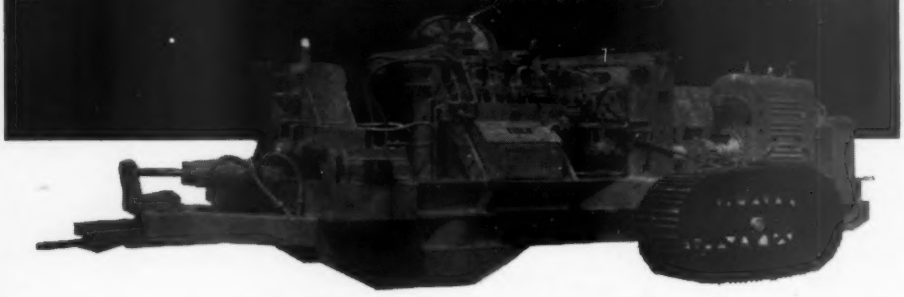

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You wouldn't think of buying steel, pumps or other similar items without seeing written specifications that tell you exactly what you're getting for your money. Then why shouldn't you buy *pipeline enamels* in exactly the same way? Why not compare enamels, specification by specification, and insist that the enamel you buy stays within those written specifications?

Published specifications of *Pitt Chem* Modified, Standard and Plasticized Enamel are available and will gladly be sent on request. Samples, too. We invite you to test the softening point, ash, penetration, and other important specifications of Pitt Chem Enamel. You'll prove to your own satisfaction that coal-to-enamel quality-control definitely does produce a true-to-specification coating that gives you better performance above ground and longer-lasting protection below.

- ★ Standard Grade Tar Base Enamel
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PROTECTIVE COATINGS DIVISION

PITTSBURGH
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left on hand. Few companies, or none, now use factory bends except in places where it is impossible to make a field bend.

Query 12. How about bends made on the job?

Answers. Bending pipe on the job is the common practice today. Cold bending with a modern bending machine or shoe, with the curvature distributed over a long section of pipe that includes no welds, is the most desirable structurally. Bends with a minimum radius of 50 ft should suffer no measurable flattening, buckling, or weakening and should allow passage to the standard scraper. Pipe that buckles should be cut out and replaced at the contractor's expense.

Query 13. Are many unnecessary bends made on the job?

Answers. A line should be laid in the most direct route from the origin to the end by the quickest practical methods of sound construction. Since it is impractical to dig a ditch to grade for a pipe line, the next best thing is to form the line to follow the terrain of the right-of-way. This can be done (1) by using weld angles or (2) by bending pipe. Where weld angles are used, it is necessary to make an additional weld and line up the joints to each end of the weld angle. When costs of weld angles, line-up time, and welding time are considered, this method is both time-consuming and expensive. With cold smooth bending of 30-in. pipe it is not at all unusual for a bending crew to make over 100 bends a day.

Many unnecessary bends are made in the normal course of a line. In fact, over half of the bends now in pipe lines are not necessary.

Query 14. Why is this true?

Answers. (1) The pipe line company's choice of route is not always the best. It is desirable to choose a route that traverses smooth terrain and is straight from one terminus to another. (2) Changes in alignment and grade can be taken care of by numerous bends that seem more economical. (3) Habit or custom has decreed that we must make so many bends to prove that we're skillful pipeliners.

Query 15. Is it necessary to make *bends to get more slack in the line?*

Answers. No. Slack is correctly produced by placing the pipe into the ditch under compression and not by making high over bends or by any snaking of the pipe into the ditch.

Query 16. Where are bends absolutely necessary?

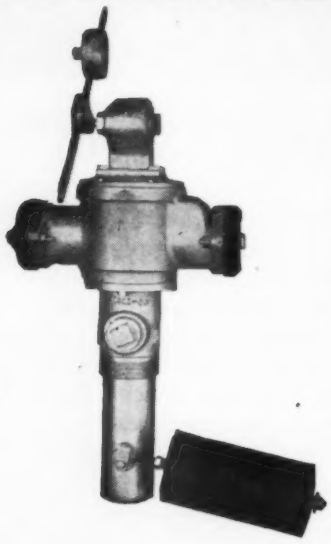
Answers. When landowners are unwilling to grant a right-of-way for a line obstructing their property, there may be no alternative. Bending pipe is preferable to adverse public relations. In congested areas or areas of difficult terrain, even additional ditching may not obviate both horizontal and vertical bends. But bends in the pipe should be used only as a last resort.

Query 17. Which is more easily repaired—a break in a bend, or a break in a straight line?

Answers. A failure in a bend is definitely more difficult to repair than a break in a straight line. On the other hand, pipe line without any bends can be pulled into the ditch so that the pipe is laid in a strain. Sometimes it might even be impossible to place a welding sleeve or leak clamp on the line because of the curvature of the pipe. Then if the pipe would break in two, it would be impossible to get a good lineup to make repairs without stripping several hundred feet of pipe in each direction.

Query 18. Is pipe weakened or strengthened by bending?

Answers. Some authorities have proved that bending causes no detrimental change in the physical properties of pipe. They claim that bending increases the yield strength materially, although it slightly decreases the ductility of the pipe. Without the modern bending machines, the pipe might be weakened; even more so if it were reclaimed and straightened. One school of thought contends that bends made during construction present a negligible



Those endless steps to check tanks are now unnecessary. With an Enardo semi-automatic fill valve, the cocking lever mechanism is also a visual indicator of fluid movement and may be seen from the ground. The lever is easy to cock from the catwalk, just push end of weight lever down and your visual indicator is set. Lever weight up, tank filling; lever weight down, tank full and oil routed to next tank.

Optional equipment on the semi-automatic fill valve is a switch that will shut down the pumping engine, actuate a light on a central control panel, or in night operations, turn on a light at the tanks.

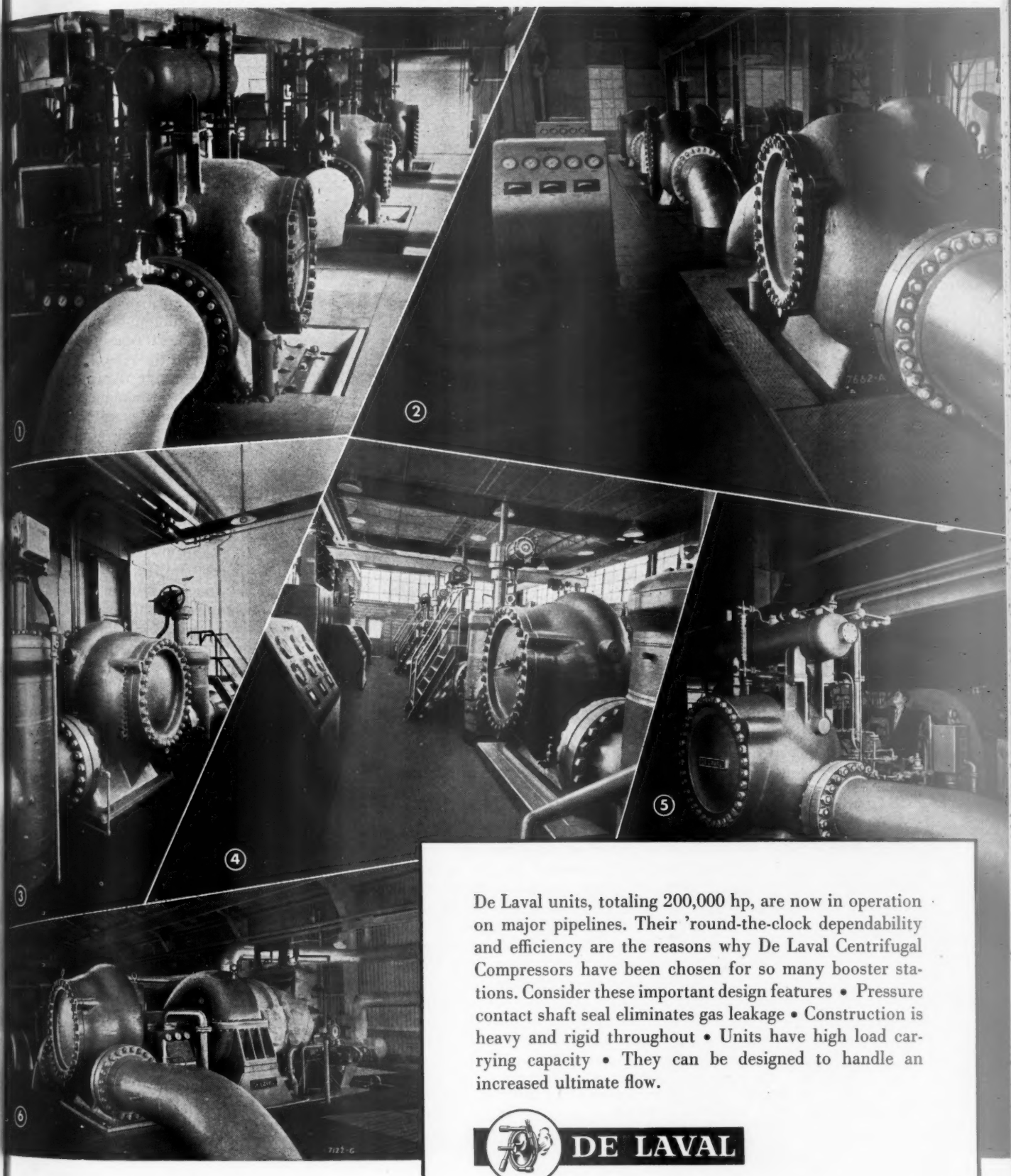
Find out how this process correlates with the Enardo Vapor Control system, by eliminating excessive opening of your hatches.

Write Enardo today for further information on the Enardo semi-automatic fill valve. Bulletin #7

ENARDO manufacturing company

BOX 1647 • TULSA, OKLAHOMA

These pipelines depend on **DE LAVAL** *Centrifugal Compressors*



Located in booster stations of:

1. *Northern Natural Gas Company*
2. *El Paso Natural Gas Company*
3. *Southern Counties and Southern California Gas Companies*
4. *Texas Eastern Transmission Corporation*
5. *United Gas Pipe Line Company*
6. *Transcontinental Gas Pipe Line Corporation*

De Laval units, totaling 200,000 hp, are now in operation on major pipelines. Their 'round-the-clock dependability and efficiency are the reasons why De Laval Centrifugal Compressors have been chosen for so many booster stations. Consider these important design features • Pressure contact shaft seal eliminates gas leakage • Construction is heavy and rigid throughout • Units have high load carrying capacity • They can be designed to handle an increased ultimate flow.

DE LAVAL

Centrifugal Compressors

DE LAVAL STEAM TURBINE COMPANY

869 Nottingham Way, Trenton 2, New Jersey

DL287

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ible pressure drop; another school of thought theorizes that bends offer expansion and contraction points for the line pipe in cases of surge and thermal movement. Bending methods have been improved notably by the use of segmented bending shoes on tractors for smaller diameters of pipe and by the use of powered, calibrated bending machines for larger diameters. Smoother bends are now achieved with negligible flattening.

Query 19. What are the generally recognized types of bends?

Answers. (1) Slight bends; (2) bends beyond the yield strength of the steel but within limits generally considered to be safe—not injurious to the steel; and (3) bends of such short radius that some type of tubeturn fitting should be welded into the line and no effort made to bend the pipe itself.

Safe limitations for any pipe bend can be computed mathematically.

Query 20. Do bends cause any costly, troublesome, or hazardous problems?

Answers. Bends always present engineering problems. If a pipe line is laid on top of the ground, the problems of anchorage, expansion, and temperature stress become mighty important and cannot be left to chance. Offset bends that are unable to transmit appreciable end thrust must not be installed unless sufficiently flexible to absorb the maximum necessary movement. All above-ground bends, either vertical or horizontal, require anchorage.

Since most pipe lines are laid under the ground, the earth acts as an anchor. Additional ditching may present problems. Some pipe lines, subject to high temperatures (up to 180 F in California, for example), have gradually crawled out of the ground where there were vertical changes in direction.

In general, no bend should be used if its cross section is deformed from circular so that any diameter differs more than 5 per cent from the original diameter. The minimum radius of curvature should be 20 times the actual outside diameter of the pipe. Pipe-wall thickness should not be reduced more than 5 per cent in the bending process. No wrinkle bends are permitted, and mitering is no longer recognized as a generally accepted means of making changes in direction. If we avoid bending with pipe, we avoid all the attendant troubles and problems that go with it.

Summary

From the collation of all these answers, what conclusions can we justly draw? A composite picture shows that many companies believe they are now making the minimum number of pipe bends in laying their lines, yet some authorities say that the number can be reduced 50 per cent.

Making fewer bends in the pipe (1) eliminates problems that arise from improper bending, ditching, and laying; (2) promotes the progress of construction; (3) keeps the pressure drop to a minimum; (4) eliminates the straightening of reclaimed pipe; and (5) reduces scrap.

Making fewer bends shifts more emphasis upon the preliminary processes of choosing the best possible right-of-way and of ditching to various depths. Cold smooth bending of pipe in the field, and then only as a last resort, is preferable to factory bends. But generally the best pipe line—and our aim is perfection—is the pipe line with the fewest pipe bends.

It is possible to lay pipe lines without any bends, and some are now being laid to prove it. If the laying of a pipe line without bending the pipe is the correct way to lay a line, the whole industry has been doing a lot of its work the wrong way for a great number of years. Surely it's time to take another look, a new unbiased look, at this pipe-laying practice. Maybe it's time to re-educate ourselves to the fact that it's possible and practicable to do something that we never before thought was possible. * * *

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PROTECTO WRAP is a hot applied protective coating in roll form for field joints on mill or yardcoated pipe, fittings, couplings and other metal surfaces exposed to above and below ground corrosion.

PROTECTO WRAP consists of a plasticized coal tar or asphalt enamel, of the types used for pipeline coating, saturated into a glass fabric that acts as a carrier and reinforcement for the enamel. PROTECTO WRAP is interwoven with a paper separator that insures even distribution of the coating as well as easy unwinding, regardless of temperature. The material is used to coat mteal surfaces where the quality of hot applied reinforced bituminous coating is desired.

PROTECTO WRAP is available in 2, 4 and 6 inch widths, fifty feet in length; and in 18 and 24 inch widths, 30 feet in length.

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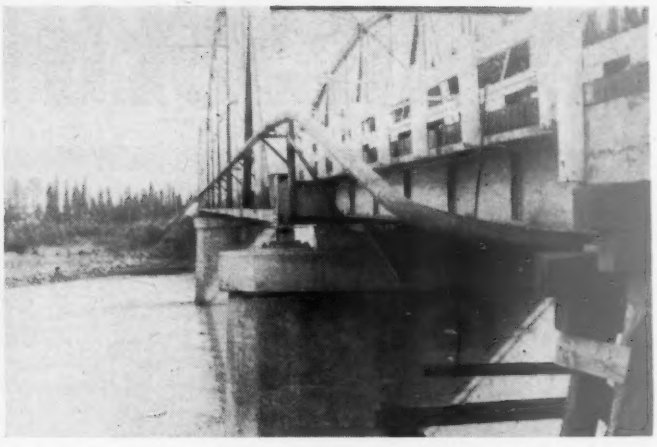
PROTECTO WRAP COMPANY
DENVER, COLORADO

Four sections of 400 ft each made up for Donjek River crossing, to be strung on bridge members.



Detail of pipe crossing on White River bridge at Mile 1126 on Alaska Highway, near Yukon-Alaska border, showing line of A-frames and sharp bend at north end.

"A" and "H" Frames, Bridges Help Solve . . .

Stream Crossing Problems in Alaska

. . . For Military Products Pipe Line

L. O. ROWLAND

HANGING a pipe line on the side of a bridge to cross a river is not new to the pipe line construction industry, but doing such a job for a line in a region where the temperature variation from summer to winter approaches 200 F requires some special design features. This unusual method of tackling a difficult river crossing assignment was done in two places of more than 1000 ft length, on the United States Army Corps of Engineers' "Alcango" products line in the Yukon Territory of Canada that it crosses on its route from Haines to Fairbanks, Alaska. Both crossings were put in successfully, in short working time, in the summer of 1954, including tie-ins, by a small crew of Williams Brothers-McLaughlin-Marwell under general supervision of Jack Engelking.

The rivers crossed were the Donjek, requiring 1600 ft of pipe, and the White, using about 1000 ft. These are the only two major rivers on the 620-mile line that have steel bridges suitable for carrying the 8-inch pipe across.

All rivers in this region are subject to extreme width of flooding in the run-off period, which may last from May until early August. In normal low water they contain as many as a dozen different visible channels, separated by wide sand and mud bars. In high water the channels merge into one torrent.

Ditching rivers of this class was considered impractical except as a last resort, as it is almost impossible to cut a deep enough ditch, at economical cost, to assure safety from washing out.

The 19-man river crossing and tie-in crew used two backhoes, a clam, two sideboom tractors, and two truck-mounted utility units, each with a welding machine. A short stretch of burial was ditched with the backhoes and the clam on each of the approaches to the bridge. Pipe sections were made up on the right-of-way, upflow from the crossing, in 400-ft lengths of 10 joints each. As the entire line was laid bare, no protection was provided for either these crossings or those that had to be buried under the smaller rivers.

A number of welded A-frames, of light structural steel, were welded to the vertical bridge side-members, at intervals of not more than 50 ft as required by the specifications for support of the pipe. To the top of each A-frame was bolted a steel loop which served as a holder and a roller to hold the pipe in place and at the same time allow it to roll in the course of expansion or contraction due to temperature changes.

Sideboom tractors were used to push each section in succession through the loops, each new section being welded to the one in front of it at the near side of the bridge.

At each up-flow approach, an H-frame of welded steel pipe was constructed to carry the pipe where it had to make a sharp bend under the deck of the bridge and across to the opposite side. These H-frames were sunk to a depth sufficient to ensure that they would not be subject to any shifting in the gravelly soil.

In the case of a number of minor river crossings with non-steel bridges, which could not be ditched because of topographical features or flow characteristics, the line was carried across on H-frames made of full-size pipe sections in 80-ft joints driven by pile-driver to refusal depth in the hardpan portion of the subsoil. These crossings were pushed one joint at a time, with

Detail of A-frame on bridge member, roller and frame are bolted on top side.

EXCLUSIVE

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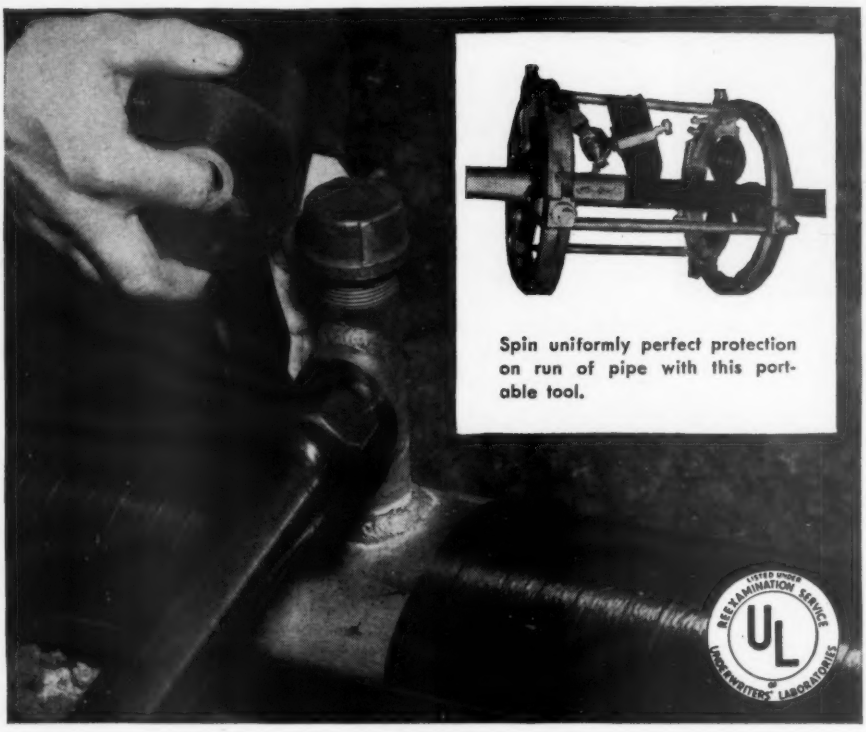

Spin uniformly perfect protection on run of pipe with this portable tool.

Fast, easy, effective CORROSION PROTECTION!

No matter who does the job, *all* your underground pipe and joints can now have *full, permanent protection* against corrosion. Dressertape—the high dielectric plastic tape—is the answer. Any crew can master the easy application techniques in minutes, save expensive man-hours and cut over-all costs on every job. *Try Dressertape yourself!*

LOOK AT THESE DRESSERTAPE ADVANTAGES!

- Available in 10-mil and 20-mil thicknesses, all standard widths.
- Fast, uniform protection is assured on run of pipe of all sizes—top, bottom and sides.
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Send today for the fully illustrated booklet *Dresser Taping Fundamentals.* Anyone can master Dresser's laboratory and field-proved methods in minutes. Also ask for our new *Corrosion Control Catalog.* Write Dresser Manufacturing Division, 89 Fisher Ave., Bradford, Pa.

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DRESSERTAPE*

Detail of concrete river weight for ditched crossings.

each successive joint being welded onto the back end as the section was pushed.

The same single-joint technique was used with steel bridges over minor rivers, on which A-frames were also used.

This type of construction was made feasible only because the rivers concerned are all too swift to be navigable. A calculated risk that had to be assumed was the possibility of washout of a bridge in any particularly severe flood. This has been known to happen in the case of one bridge on the Alaska Highway, on which both the bridges carrying the line are located.

Ditched crossings were spanned by pipe sections made up on shore and pushed across. Concrete river weights were cast on the job and attached in pairs weighing 480 lb at 40-ft centers. The negative buoyancy of 200 lb displaced 280 lb of water for each pair, and they settled into the ditch in every case with complete satisfaction.

One of the most perplexing features of the engineering on all river crossings was the individual river "personality" problem. In every case, the local factors had to be appraised for that particular crossing, as no generic characteristics could be derived from the answers to the basic engineering questions:

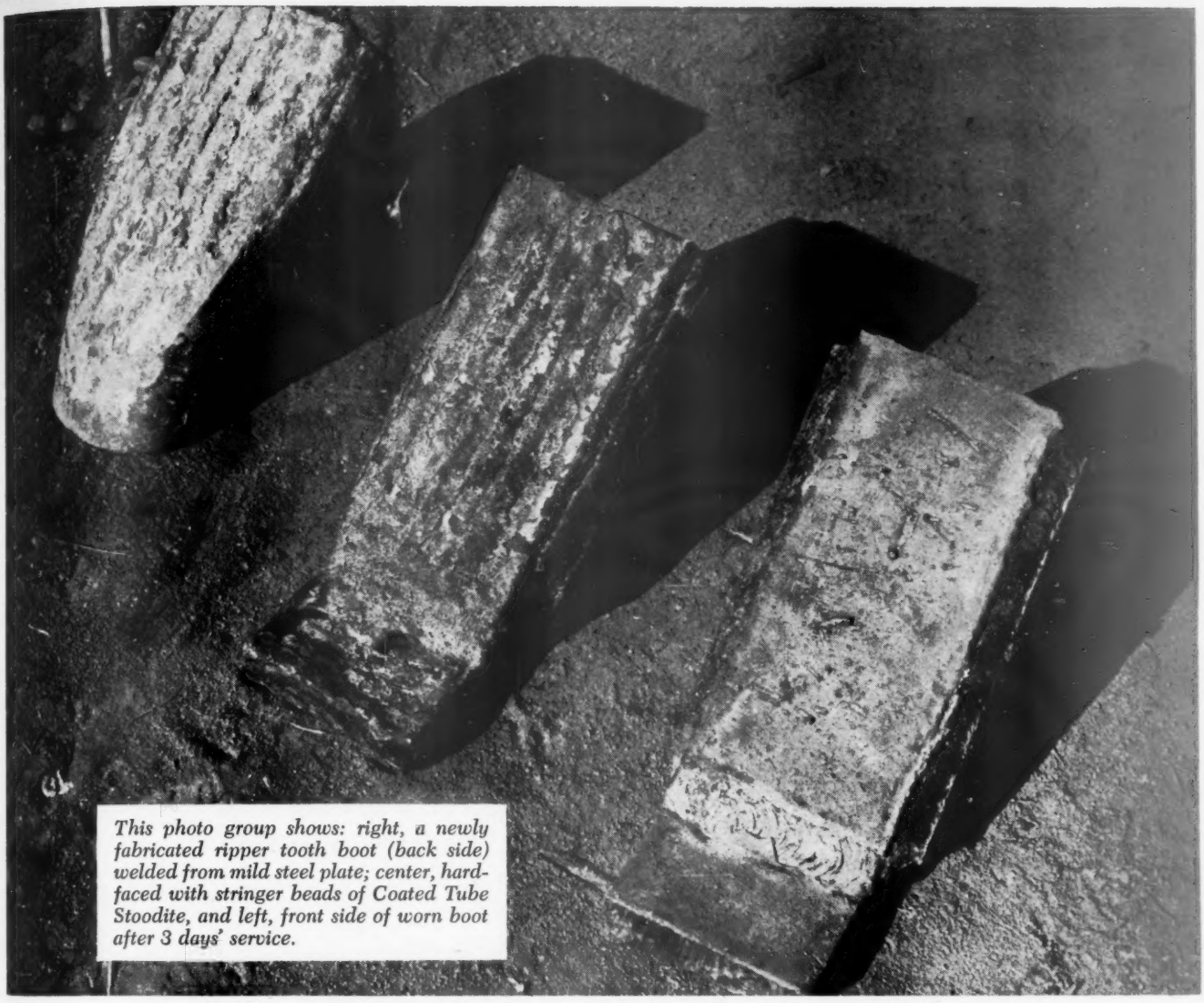
What is the probability of the crossing area becoming a flood plain?

Will a possible flash flood wash out the right-of-way or even lift the pipe out of the river bed?

Does the river change course frequently?

The composite of the answers to these questions determined whether the river would be ditched, crossed by H-frame, or crossed by stringing along the bridge frame.

All pipe for major river crossings which had to be ditched was specified 0.312-in. wall thickness (ordinary pipe used was 0.277 in.) and was buried with 9 ft of cover. * * *



This photo group shows: right, a newly fabricated ripper tooth boot (back side) welded from mild steel plate; center, hard-faced with stringer beads of Coated Tube Stoodite, and left, front side of worn boot after 3 days' service.

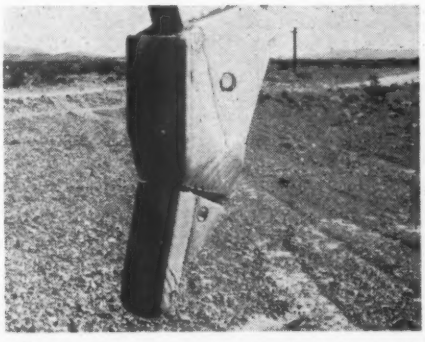
HARD-FACED RIPPER TOOTH

Lasts 1200% Longer on Desert Duty!

Near Ludlow, California, PG&E is spanning the vast Mojave Desert with a gas pipeline. To ease the trenching job a gigantic ripper is towed by a D7 tractor ahead of the ditcher. Its purpose is to break up the hard-packed earth and locate the frequent sub-surface lava flows. This lava is so hard and tightly bonded that explosives must be used to break up the formation.

Depth at which ripper operates is evident by length of standard.

The ripper on this job is designed for easy maintenance; boot type point and adapter are replaceable. The points are fabricated from mild steel plate in the division headquarters maintenance shop of the pipeline company handling the job, Engineers Limited Pipeline Co., Bakersfield, California. All four sides are hard-faced with Coated Tube Stoodite before being placed in service.



Close-up shows point attached to tooth adapter. Entire tooth is hard-faced with Coated Tube Stoodite.

Working deep in the highly abrasive earth, unprotected boots last only 2 hours. When hard-faced with Coated Tube Stoodite this short life is extended to three full days—an increase of 1200%.

Coated Tube Stoodite is a recent Stoody development for manual application, combining high wear resistance, good impact strength, fast deposition and low cost. Ask your Stoody dealer for details (consult the yellow pages of your phone book) or write direct.

STOODY COMPANY
11955 East Slauson Avenue
Whittier, California

Preventive Maintenance on Main Line Station Compressors and Engines†

GLENN VAIL*

PRIOR to World War II, it was possible to set up a maintenance program for large gas engines without giving too much consideration to the type. Following the war, with the advent of high compression ratios, super-charging and the acceptance by the natural gas transmission industry of higher speed units, it was recognized that it would be necessary to revise the thinking regarding the frequency of overhauls, and that the various types of engines would require individual treatment.

The 7 units installed at the Blythe Compressor Station in 1948 were of the 2-cycle, semi-high compression type, of which there were very few in operation at that time. A maintenance program was set up with a complete set of records to be used as a guide in future overhaul scheduling. Additions since 1948 have been 8 high-compression units—2 in 1949, 1 in 1950, 2 in 1953 and 3 in 1954, making a total of 15 compressor units in the plant.

At Desert Center and Cactus City, California, gas driven centrifugal compressors are used. Each of these stations is a single unit station. The gas turbines are 5700-hp regenerative cycle, 2-shaft units, and the centrifugal compressors are single stage equipment.

Maintenance Scheduling

The original program at the Blythe station was started assuming that the units should be inspected once a year, or every 7000 hours of operation, with these inspections scheduled during that part of the year when the horsepower requirements of the plant were lowest.

Considerable thought was given to the overall maintenance program regarding the manpower that would be required at these overhaul periods. It was decided that when a unit was taken out of service for routine inspection and overhaul, the word should progress 24 hours a day, 7 days a week until

MAINTENANCE INSPECTION

ENGINE #_____

The items checked below were inspected and found to be in satisfactory condition, with the exceptions as indicated on detail sheets.

TO BE CHECKED	ITEM
1	POWER PISTONS, RINGS, CLEARANCES, ROD BEARINGS
2	POWER CYLINDERS, CLEARANCES
3	AIR STARTING CHECK VALVE, SEAT, SPRING
4	FUEL INJECTION VALVE, SEAT, SPRINGS, ROCKER ARM
5	SPARK PLUGS, COILS, WIRING MAGNETO
6	FUEL CROSSHEAD, ROLLER, SPRING, BEARING
7	MAIN BEARINGS
8	COMPRESSOR ROD AND SCAVENGING ROD BEARINGS
9	AIR STARTING VALVE, SEAT, SPRING
10	BUTTERFLY VALVES, PORTS (INTAKE & DISCHARGE)
11	CAMSHAFT, BEARINGS, CAMS, THRUST
12	CAMSHAFT & GOVERNOR DRIVES, CHAINS, SPROCKETS
13	LUBRICATOR AND MAGNETO DRIVE (SEALS)
14	GOVERNOR AND GOVERNOR VALVE
15	OIL PUMP
16	COEN FILTER AND PUROLATOR ELEMENTS
17	OIL COOLER
18	OIL RELIEF VALVE
19	OVERSPEED STOP MECHANISM
20	SCAVENGER AIR VALVES, SEAT, KEEPERS, INTAKE BOX
21	SCAVENGER CROSSHEAD, OIL WIPER PACKINGS
22	COMPRESSOR CROSSHEAD
23	CRANKSHAFT
24	COMPRESSOR PISTON, RINGS, CLEARANCES
25	COMPRESSOR CYLINDER, CLEARANCES, OIL & COMPRESSOR PACKINGS
26	LIFTERS
27	POCKETS
28	COMPRESSOR VALVES
29	FLANGE ALIGNMENT CHECK
30	AIR FILTER MUFFLER SUPPORTS
31	ENGINE PIPING AND SUPPORTS
32	PRESSURIZE WATER JACKET (AFTER ASSEMBLY)
33	FILTER OIL AND CHANGE NUGENT PACK

† Presented at CNGA Fall Meeting, Los Angeles, California, 1954.

* Southern Counties Gas Company, Blythe, California.

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STOP PIPE-LINE SHUTDOWNS

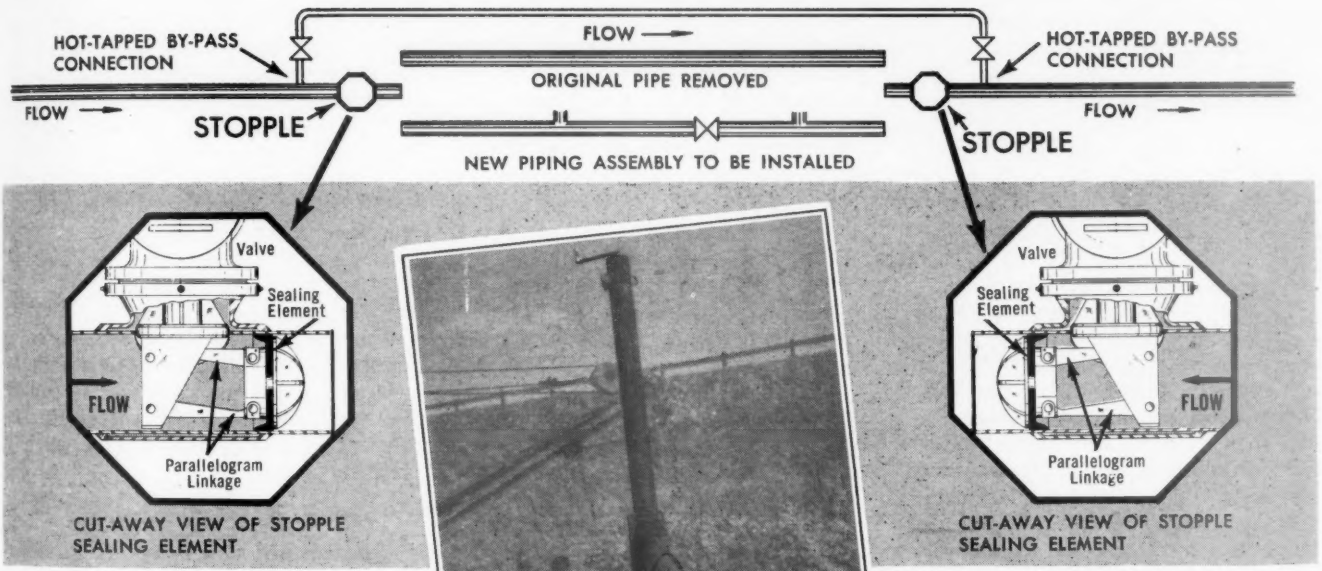
with the WILLIAMSON STOPPLE

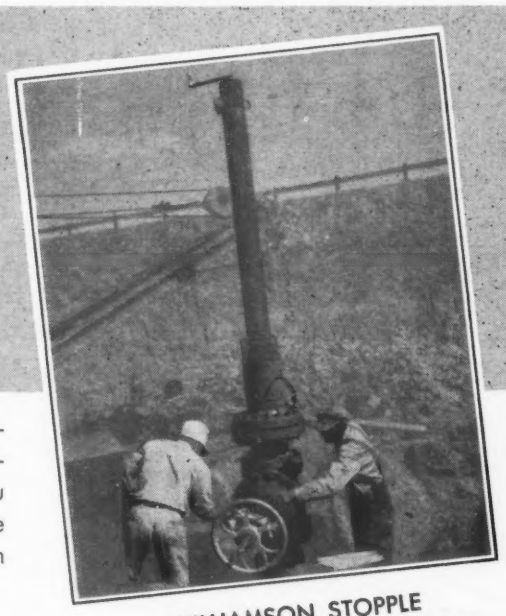
T. D. WILLIAMSON, INC.
TULSA, U. S. A.

CONTINUE TO OPERATE THROUGH A BY-PASS

While making repairs or additions . . .

TYPICAL PIPING CHANGE





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HOLDS PRESSURES UP TO 1,000 PSI DEPENDING UPON PIPE SIZE, WALL THICKNESS AND CONDITION.

Experienced Williamson representatives, factory-trained engineers, are on hand to offer you their assistance in the proper use and installation of Williamson STOPPLES.

STOPPLES are available for purchase or rental with purchase option.

STOPPLE SIZES NOW AVAILABLE*			
4″	6″	8″	12″
	16″	20″	

STOPPLE SIZES IN PRODUCTION			
10″	14″	18″	22″

*Allow 2 to 4 weeks for assembly of accessory parts. Stopple stock subject to prior sale.

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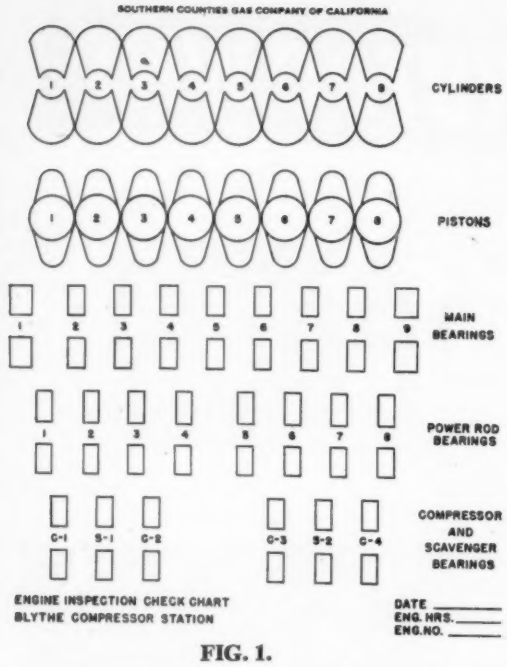

FIG. 1.

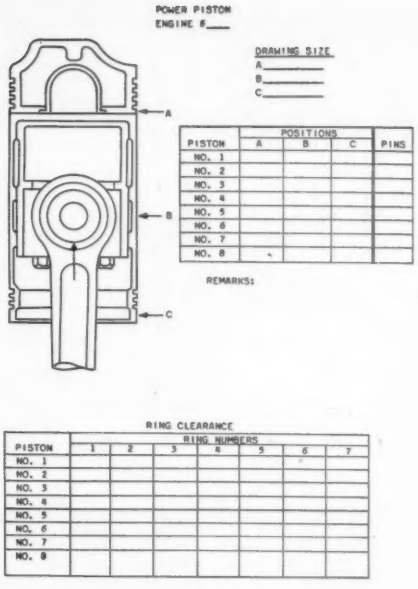

FIG. 2.

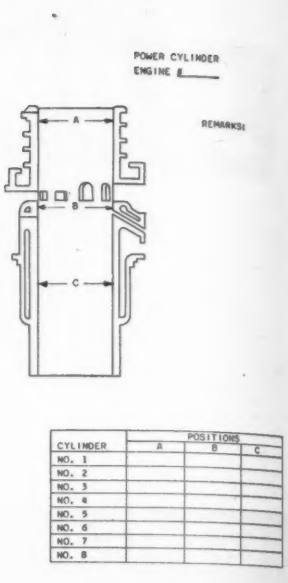

FIG. 3.

completed. For a program such as this to function efficiently, it was essential that all operating personnel be trained in the maintenance and overhaul of the engines, and that a maintenance crew, as such, would not be required. This decision was influenced somewhat by the idea that an operator who thoroughly understood and assisted with maintenance of the units would be a better operator and be more interested in preventive maintenance.

Check Sheet Used

To initiate this program, a check sheet was prepared listing 33 items. Then a set of sheets based on each of the 33 items was sent into the field. These sheets provide either boxes or equipment sketches with critical measurement points on which are recorded the results of inspection, replacement, clearances, etc. These field copies are then returned to the office for analysis and transcription to permanent records to be used for future reference. To assure that proper maintenance methods were used, job breakdowns were made for the more critical operations.

The items on the check sheet are listed in the order in which they should be performed to avoid overlapping and interference. The sequence provides that initial disassembly include all equipment that might require machine work. Each shift then continues with the current job rather than start another. Thus, the program serves to acquaint each employee with the various jobs rather than produce "specialists" in certain items. This, of course, does not mean that two consecutive jobs cannot be progressing at the same time time so long as the general sequence is not interrupted and manpower is available.

The first two lines of sketches on Fig. 1 represent exploded views of the power cylinders and pistons. Upon these, all scratches, scores and unusual conditions are recorded. The boxes on Fig. 1 represent the bearings; in the boxes are recorded any spots or unusual conditions, and at the sides and ends of the boxes are recorded the clearances and crush.

Fig. 2 shows the power piston and information recorded.

Fig. 3 shows the power cylinder.

Other sheets are used to record information pertaining to items listed on the check sheet not covered by Figs. 1 through 3.

All minor maintenance work performed between these regular inspection periods is recorded in a maintenance log book which has separate sections for each unit.

Between these routine inspections, other preventive maintenance and operational checks are made on the units. The power cylinder compression and firing pressures are recorded, and the units balanced each month. The overspeed trip, low oil pressure switch, and high water temperature cutout are checked every three months. The magneto points and spark plugs are checked every 2000 hours of operation.

The crankcase and lubricator oil usage is reviewed monthly, and when out of line, is investigated. The scavenging air and crankcase pressures are checked and recorded weekly.

Routine Procedure

In any engine maintenance program, there are a number of operations and tests that can be set up as a part of the routine operational procedures.

Typical standard operating practices that could be classed as preventive, and which would appreciably diminish downtime and maintenance cost include:

- a reasonable warm-up period before applying load to allow internal parts to attain operating temperature;
- idling for a few minutes before shutdown to minimize carbon formation in the ports and piston heads;
- frequent horsepower checks to avoid overload, a serious contributor to higher maintenance cost;
- vigilant attention to pyrometer readings to arrest minor localized trouble and/or general unbalance;
- insistence that design speed be maintained to prevent operation at slower speeds under conditions which would be "overload" at rated speeds. Load variations would then be adjusted by pockets or lifters.

Special Tools

Special time and labor saving tools are used in our maintenance program wherever possible. Of these, *impact wrenches* are used in disassembly only. *Air hoists* are provided in all the engine rooms. A *portable platform* is mounted over the compressor cylinders during the overhaul periods for the storage of the power cylinder heads and upper gear. *Jigs* are provided for operations such as fitting compressor and scavenging rod packings, bearing liners, etc. *Torque wrenches* are used in the reassembly of the more critical parts, such as the power cylinder heads and the bearings, to get a more uniform stress on all the bolts. Other special tools have been developed for the handling, disassembly and reassembly of various engine parts. These special tools were developed either directly by the plant people or through the interchange of information and ideas

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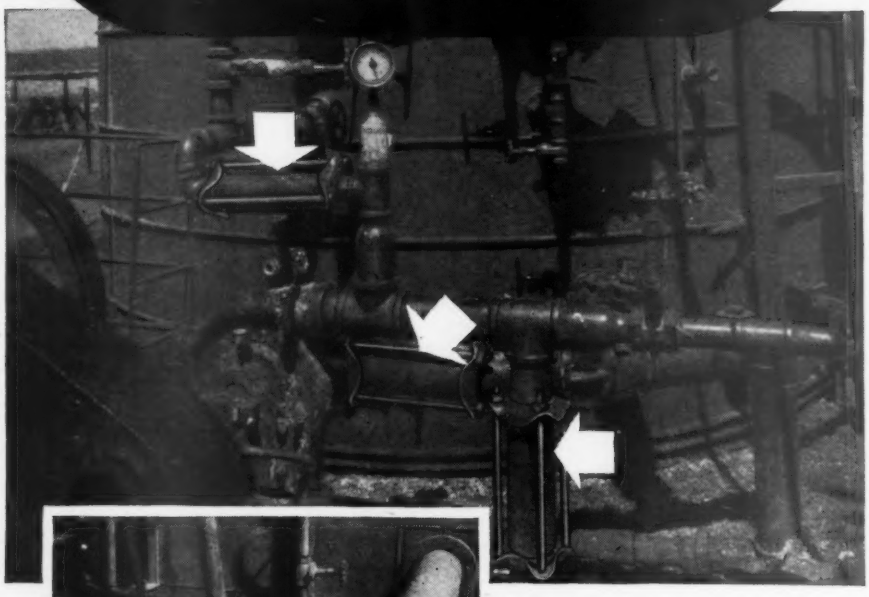

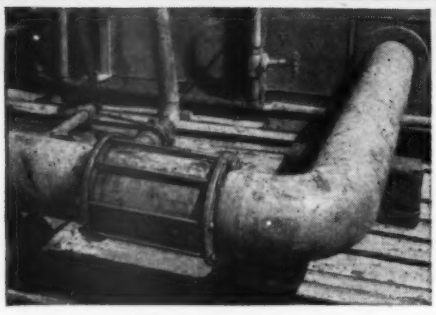

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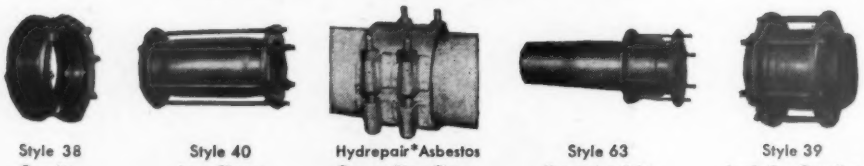

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with other companies with similar equipment.

Program Successful

This maintenance program, and the records kept, are now beginning to bear fruit. The necessity for calling a crew out for emergency engine maintenance has been eliminated, and a review of the Engine Maintenance Log Book for the first nine months of this year, for example, shows that major maintenance between inspection periods has been nil. The overhaul frequency for the semi-high compression units has been fairly well established, and the intervals for the inspection of the high compression units are taking shape.

Maintenance experience to date indicates that the semi-high compression units should receive a major overhaul at about 10,000 hours, and the high compression units should be overhauled at approximately 15,000 hours. Minor maintenance might be required between these overhauls, such as rod-packing adjustments, fuel injection and air-starting check valve reconditioning, and compressor crosshead float adjustments.

The time required for a major overhaul is about 600 man-hours. This varies with the number of adjustments and replacements required; the overall time being 7 to 10 days.

The difference in the time between overhaul periods for the 2 types of engines was brought about by the higher compression ratio, improved design of the power pistons and power cylinders, larger crankshaft with precision bearings, and larger scavenging cylinders on the high compression units.

It is anticipated that the maintenance on the gas turbines will be very nearly the same as would be expected with large steam turbines. The maintenance program for these units is set up for major inspections every 25,000 hours of operation, with a minor inspection scheduled between each major. The two turbine stations were placed in operation in the summer of 1953, and in the summer of 1954 it was decided to give the Desert Center station a major inspection as it was possible that this unit would be required to handle the increased rates next year, and that the Cactus City plant would be given a minor this year.

The Desert Center unit was completely dismantled and all parts inspected during July.

In August, the Cactus City unit was shut down and given a minor inspection. This consisted largely of dismantling enough for the inspection of the combustion chambers and the axial flow compressor. The one-stage compressors were also inspected. ★ ★ ★

Diagnosing Compressor Troubles With Instruments†

FRED H. NOLTIMIER*

THE history of preventive maintenance for compressors[1] is somewhat analogous to that of the weather that provoked Mark Twain's famous remark. So far, this has irked the meterologists into seeding clouds to produce rainfall (sometimes). Some other motive, probably the desire to lower maintenance costs and reduce embarrassing downtime,[2] initiated thinking of preventive maintenance well over two decades ago. Proof of progress is well evidenced by the various papers and published articles discussing not only methods to most economically repair inevitable wear, but also procedures to schedule major repair work and prepare check sheets to insure proper inspection of equipment at due times and securing of data useful for future planning.[1,2,3,4]

As the many benefits of properly scheduled overhauls have been so well reviewed, it is to the purpose of this article to attempt to present a few methods of quickly and accurately ascertaining incipient mechanical problems and failures before they become acute and complete failures occur—as they sometimes do, prematurely, before scheduled overhauls. Such failures are abnormally costly as they usually interfere with work in progress, involve overtime, and may result in decreased plant capacity and loss of revenue.

Instruments Required

The instruments cited are not listed in order of importance—as their necessity, as well as their use in conjunction with certain of the other instruments, is determined by the location and nature of partial failures to be ascertained:

1. Engine indicator (recording card type)
2. Pressure indicator (average and maximum pressures)
3. Pyrometer, with thermocouples close to each exhaust port
4. Scavenging air pressure gage or manometer
5. Manifold depression—intake manifold vacuum gage or manometer
6. Combustion indicator or exhaust gas analyzer
7. Thermometer wells or temperature indicators for:
   a. Gas to and from each compressor cylinder
   b. cooling water from each compressor cylinder
   c. Cooling water to and from each bank of power cylinders
   d. Cooling water to and from each oil cooler
   e. Lube oil to and from each oil cooler
8. Neon glow bulb
9. Neon timing light
10. Water manometer on air intake systems
11. Stethoscope (mechanical)

Use of Instruments

Item 1. The engine indicator is rather an expensive and intricate instrument. Hence, to secure its complete and varied usefulness which requires careful manipulation and interpretation, an experienced technician is required. Of course, the taking of accurate complete cards on the modern higher rpm angle type compressors is more difficult than the older, horizontal slow speed units for three reasons:

1. Longer synchronizing wires having to travel over 1 to 3 pulleys increase card distortion due to lag caused by friction and inertia. Inertia alone varies as WR^2 or is 4 times as great at 4000 rpm as at 200 rpm.
2. High cost and low availability of suitable indicator reducing motions.
3. More "downtime" for rigging up, and greater technical skill.

"Pull cards" on the engine indicator may readily be taken at any location and existing pressures permanently recorded in their true pattern, providing the frequency is not too rapid for the capability of the indicator. However, the opening from cylinder to indicator must be of ample size to prevent a resonance amplification[1] if used on medium or high speed power cylinders, or a "damped" pressure record if used on cylinders or gas lines.

Item 2. Pressure indicators,[2] of a type which instantaneously indicate either the average maximum or near unusual peak explosion pressures are moderate in both initial and maintenance costs. They are rugged, and a good mechanic can accurately interpret much from their readings.

Item 3. Pyrometers with thermocouples near each exhaust port proved their value in large diesel engines, both 2 and 4 cycle, prior to their becoming standard equipment on almost all 2 cycle gas-fueled compressors. In our own organization we so equipped a few 4-cycle gas fueled compressors some years ago. We have found, on both types of engines, that although the pyrometer may not always pinpoint an undesirable condition, it affords the quickest means of ascertaining the fact that something is amiss.

A simple case of unbalanced loading created by uneven fuel distribution or improper mixtures can usually be quickly corrected. Other causes may require the use of one or more other instruments and from a quick correlation of the several data the focal point of improper operation be determined.

Item 4. A mercury-filled manometer appears preferable as scavenging air pressures are low, accurate readings are necessary, and accurate gage maintenance is both difficult and expensive because of vulnerability to pulsation and vibration.

Item 5. Intake manifold vacuum indicators, usually a permanently mounted mercury-filled manometer, have proven useful on 4-cycle engines. An accurate MD vs rpm and load curve, compared with taken data quickly gives an "OK" or "something "BO."

Item 6. A portable combustion indicator is of value only when checking 4-cycle engines. Engines may apparently be operating well but with a fuel mixture 10 per cent or more on the rich or lean side. A quick analysis and fuel adjustment may save 10 per cent in fuel, or burned valves and seats. Of course, the mixture may be re-set to the blast of an open test cock or to maximum MD but the flame is hazardous and either is at best only a close approximation.

Item 7. Provision for thermometer wells or temperature indicators can least expensively be made during construction. Their general usefulness and, at times, their necessity is apparent.

Item 8. A neon glow bulb is an inexpensive item useful for quick checking of relative voltage and milliamperage being transmitted through individual wires of a non-metallic shielded hitension ignition system. When held in close proximity to a spark plug lead, it is actuated by the wire's induced current field, and partial or non-delivery from the magneto, lead wire, or "step-up" coil is immediately evident. How-

†Presented at CNGA Fall meeting, Los Angeles, California, 1954.

*General Petroleum Corporation, Los Angeles, California.

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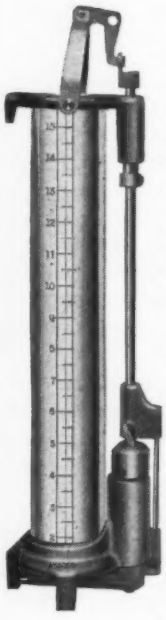

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ever, if current delivery to the plug is good, it cannot indicate actual plug performance.

Item 9. Timing lights of the neon type, particularly if the primary side is assisted by 6-8 v, can be used in daylight and without any interfering withdrawal from conventional ignition systems. Once the flywheel is properly marked by stamping, the firing time on one or all cylinders can be readily checked.

Item 10. Infrequently conditions arise that interfere with normal flow of combustion air through the air cleaners and connecting piping to fuel mixing boxes or scavenging cylinders. A minutely excessive pressure drop seriously affects engine performance. Because of this factor, usually the last to be checked, some operators permanently install a short water manometer at time of compressor installation so that any deviation from ideal pressure will be readily and quickly noticed.

Item 11. Mechanical stethoscopes—or auscultators, if you prefer the medical terminology—have evolved from the original slender steel bar held between the teeth while the ears were muffled. There is offered for sale a chromium plated probe wired to a complex and delicate electronic portable set that finally transmits mechanical sounds to the ear via a pair of padded earphones. Some mechanics report excellent results from home-made versions comprising merely a probe attached to a discarded earphone.

If an unnatural sound can be heard sufficiently well for analysis and/or location by means of its isolation or depression of surrounding noise level, an experienced mechanic can often save much downtime and expense by so spotting an unusual or premature mechanical failure which otherwise might result in a very costly repair.

Diagnostic Roles of Instruments in Premature Failures

Despite the execution of a most carefully scheduled plan of preventive maintenance, infrequent early failures will occur. These cases of apparent power-fading may be caused by invisible accumulative effects of improper operation, or by partial or complete failure of some small but vital expendable part. A scheduled unit "downtime" may be months in the future and the repair crew busy on a vital job.

Proper instruments will often assist a skilled mechanic and helper in quickly locating the cause. A short shutdown, no calling out a full crew, replacement or reconditioning of one or several parts, and the unit is back on line to so stay until the originally scheduled repair time. To better illustrate, a few typical instances will be cited.

Case 1: Two cycle compressor, loss of power.

Indications: Abnormally high exhaust temperatures, sub-normal scavenging air pressure, stethoscopic sound of "blow-by" through discharge valves of warmest end of scavenging cylinders.

Repairs: Replacement of several broken reeds.

Downtime: 45 minutes.

Case 2: Two cycle compressor, gradual loss of power.

Indications: All customary quick checks appeared normal.

Check of log: Unit within two months of pre-scheduled repair time, extended because of average low load of 90 per cent of rating.

Check with pressure indicator: Compression pressures slightly low, explosion pressures low, particularly on two cylinders.

Repair: Replacement of two fuel injection valve assemblies as deep seating of valves into seats impaired mixing and distribution of fuel.

Downtime: 30 minutes.

Case 3: Either two or four cycle compressor, inability to carry rated load.

Indications: All customary quick observations appeared normal excepting exhaust temperatures that were slightly unbalanced and did not consistantly respond to mixture changes. A considerable amount of "cut and try" adjustment work had been done.

Repairs: Consulting mechanic, using neon timing light, found magnetos correctly timed to their conventional timing cylinders. Most of the other cylinders were out of time, some as much as 15 deg plus or minus. Magnetos were replaced, load balance re-adjusted, and unit loaded to rating.

Downtime: four hours.

Case 4: 4-cycle compressor, gradual loss of power.

Indications: Low MD for speed and load. Slightly high exhaust temperatures on two cylinders. Pressure indicator showed rather even and normal compression pressures but low explosion pressures on the two cylinders.

Repairs: Pulled heads on said cylinders, found exhaust valves seating very deeply, and why. Replaced parts as required. Engine replaced on line at regular loading.

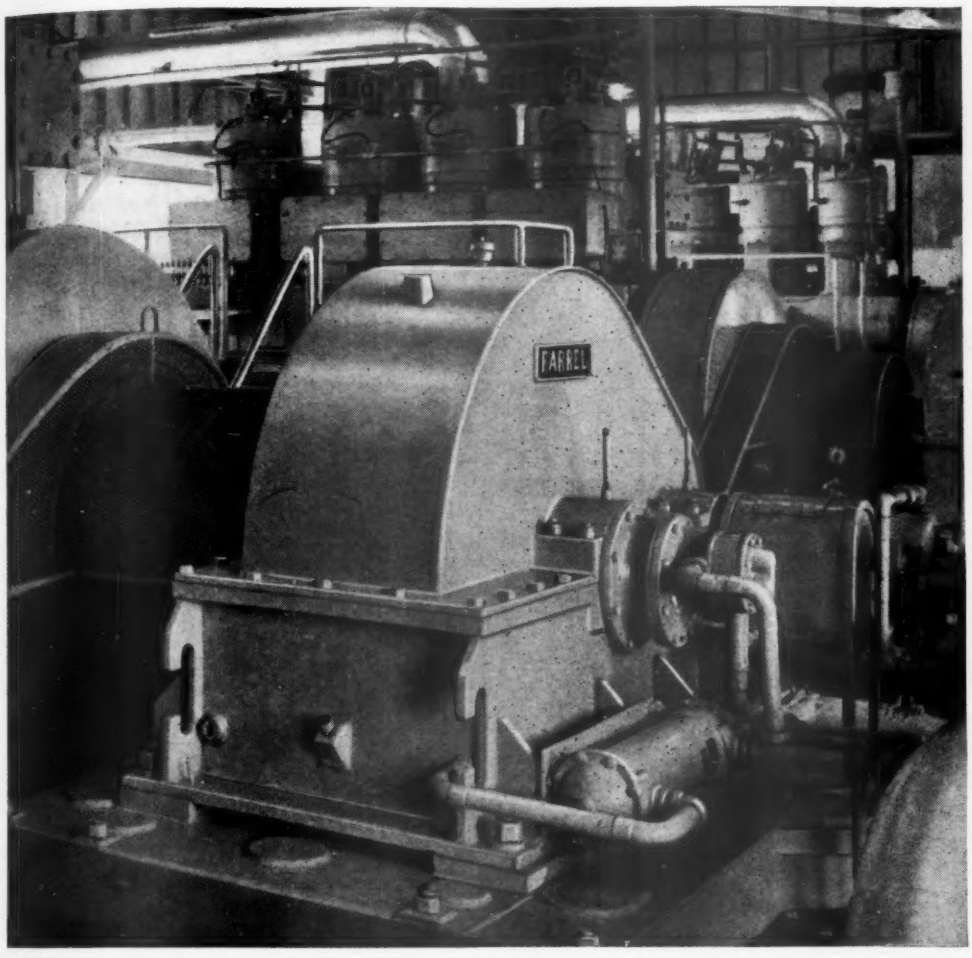
Downtime: Eight hours.

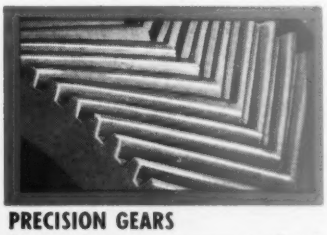
Labor: Two man-days.

Case 5: Two stage compressor, one of many operating in parallel, gradually appeared to be overloaded.

Indications: Eight months until due for overhaul, no perceptible decrease in total metered capacity, no unaccountable change in stage pressures, and no hot compressor valves.

Farrel speed increasers give you smooth power transmission year after year . . . here's why





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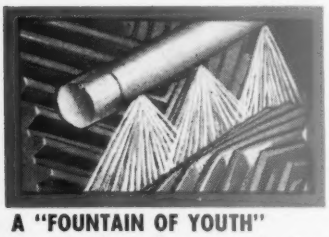

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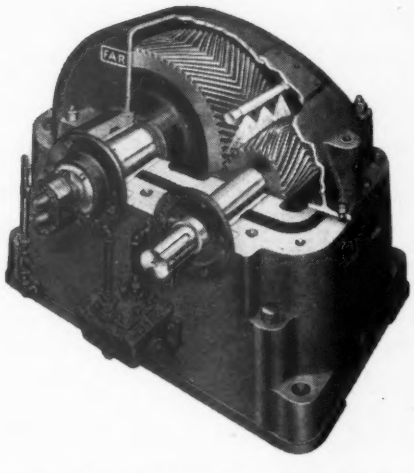

Farrel speed increasers in operation, including those originally furnished twenty-two years ago, now total over a quarter of a million horsepower.

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Repairs: Suction and discharge temperatures of all cylinders were taken and correlated. Gas through high stage cylinder of questionable unit had slightly the greatest temperature rise. Piston and valves were pulled. The valves checked for further usage but the piston rings were severely worn, evidenced considerable slippage, and subsequent power loss. They were replaced and unit performed normally.

Downtime: Three hours.

Case 6: One of a number of identical units, installed simultaneously and operating in parallel, had always appeared to be slightly lacking in power. Service mechanics had reported one bank of power cylinders as being slightly below par, for no apparent reason. Complete indicator power cards had not been taken because of the complications of synchronization.

Indications: After some years of operation, plant load was reduced and engine used only as spare. Plant mechanic, through use of good pressure indicator, found noticeably lower average explosion pressures in questionable bank.

Repairs: Engine carefully trammed and firing point marking on flywheel for magneto serving weak bank was found to be almost 10 deg late. Correction was made and engine performance became normal.

Before and After Inauguration of Preventive Maintenance

A specific case of "before and after" to prove, in dollars and cents, the actual value of a preventive maintenance program, is most difficult to illustrate. Such a program is not something that you buy (possibly subject to approval) and place in full scale operation. Rather, it is a function of operation and maintenance that gradually grows and spreads, swiftly here and slowly there. Other factors add to the complexity of merely searching back through records of 10, 15, or 20 years ago. Does the accounting procedure truly represent the picture? What of the effect of inflation, changes in plant, and unit load? Compressor units, then relatively new, are now older and reasonably require more maintenance.

To attempt to answer the question may I say that during the past several years I have heard expressions regarding preventive maintenance from many men from many organizations in our field. Very few will deny it has merit, many are believers in the practice.

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Development of the Modern Gas Engine Compressor Plant

LYMAN F. SCHEEL*

TWENTY years ago the gas engine driven compressor plant was used for the gathering of low pressure gas in the oil fields, gas lifting of oil and transmitting limited quantities of natural gas distributed by the utilities. The plant was equipped with heavy, slow speed, horizontal engines, bearing a marked likeness to their predecessors, the steam engines. The sizes varied from 150 to 1200 hp. The natural gas industry received a great impetus some 15 years ago when the vast gas reservoirs of Texas were tapped with the "big inch" lines going east, north and to the west coast in 1946. The gas engine compressor plants were a necessary adjunct to this expansion.

Fig. 1 illustrates the relative unit cost in dollars per installed horsepower for typical gas engine compressor plants of the past 20 years. Class "A" plants were equipped with the common 200 hp, twin, horizontal engine of a decade ago, as illustrated in Fig. 5.

Ten years later the Class "B" higher speed, angle or "V" engines had replaced the Class "A" engine. Fig. 6 illustrates typical Class "B" plants. The housing structure had advanced from corrugated sheet iron on wooden frame to transite on rigid frame steel buildings; open jacket-water systems became enclosed, water-sprayed tubular coolers; gas coolers of 2-in. pipe also became tubular coolers; air cleaners and oil filters were accepted and air-cooled mufflers silenced the barking exhausts.

Class "C" plants consist of the large, slow speed, tandem engines as illustrated in Fig. 7. Table 2 gives the unit cost for Class "C" plants. Case "C" shows the influence of war economy on the large tandem engines.

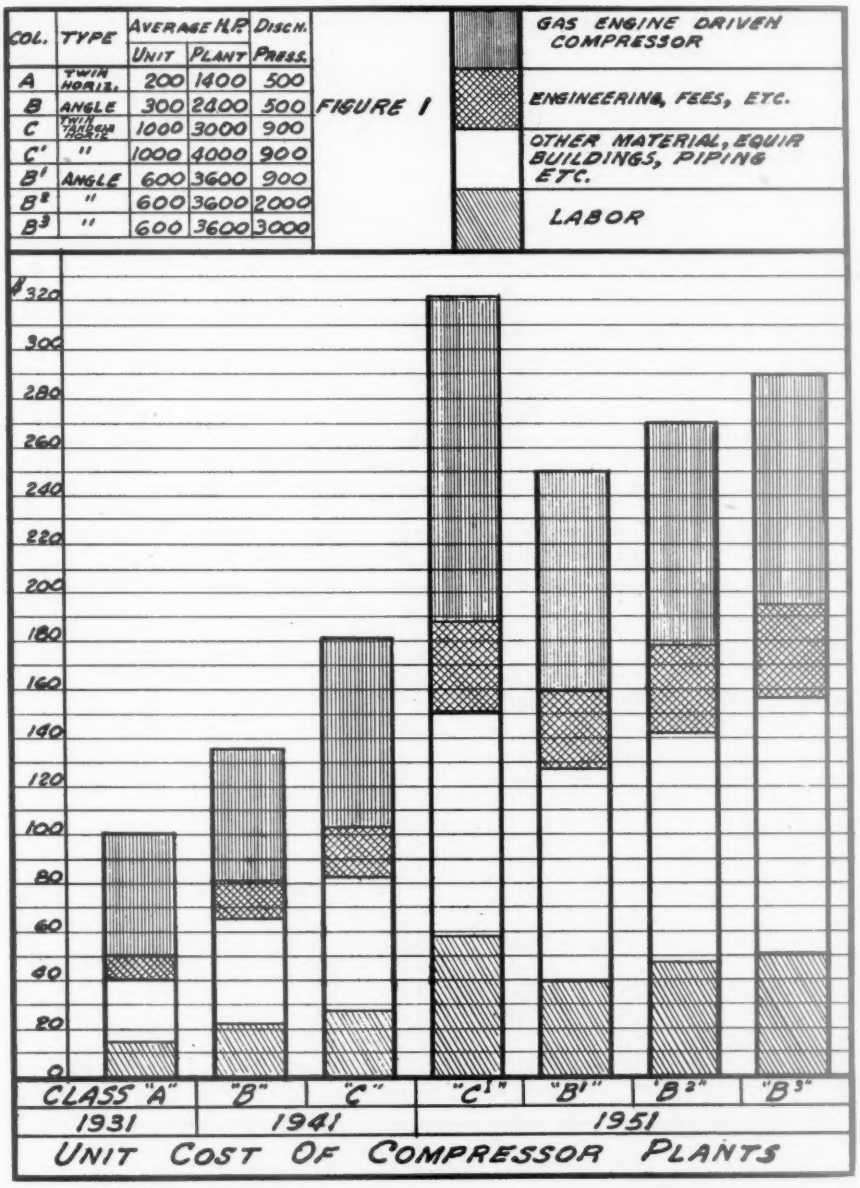
Table 1 gives a detailed breakdown on the plant cost of Class "A" and "B" plants for the past three 10-year periods. It will be noted that the improvements made in 1941, cost apparently 44 per cent more than the bare essentials plant of 1931. This accounts for the 61 per cent increased plant cost compared with the 20 per cent general rise in labor and material reported by the U. S. Bureau of Commerce.

The next decade saw the addition of more automatic controls; overhead traveling cranes; pulsation dampeners; induced draft cooling towers and the application of air-cooled auxiliaries. Fig. 8 illustrates Class "B" plants of this period. The improvements contribute substantially to the $250 plant cost. Presuming that a 1931 plant could have been duplicated in 1951 without the refinements related, it would have cost $206 per hp by using the Bureau of Commerce indices. This would indicate that these refinements cost $44 per hp.

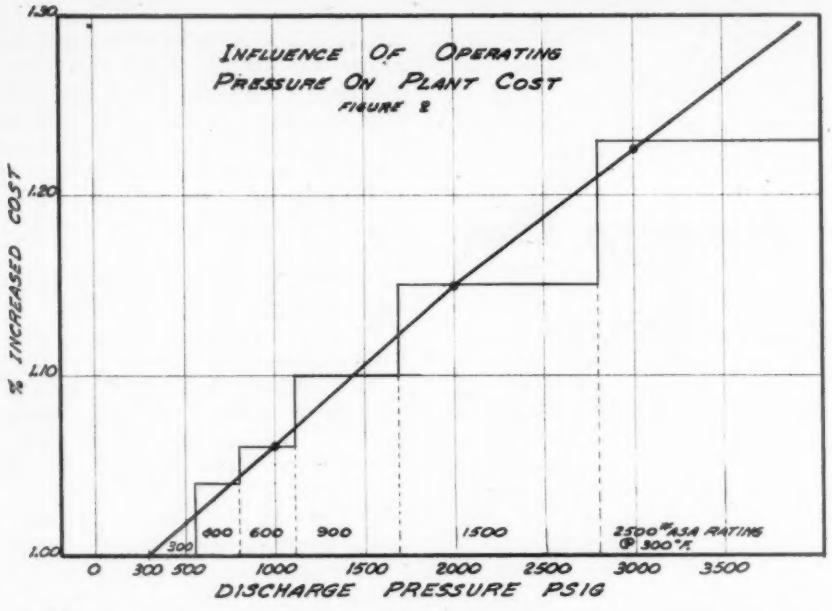
Justification of these refinements is the crux of this study. The answer lies in the operating expense of such plants. Table 3 shows the operating expense items as accumulated over the past 25 years from typical California operation. The average of 5 compressor plants, exemplified as Class "A" in Table 3, indicates a power cost of $2.08 per hp month in 1931. Two decades later these same plants have a power cost of $5.34 per hp month. The advanced design plants currently cost $3.07 per hp month. The difference in the operating expense of the older design plants compared with the advanced design plants is an annual pre-

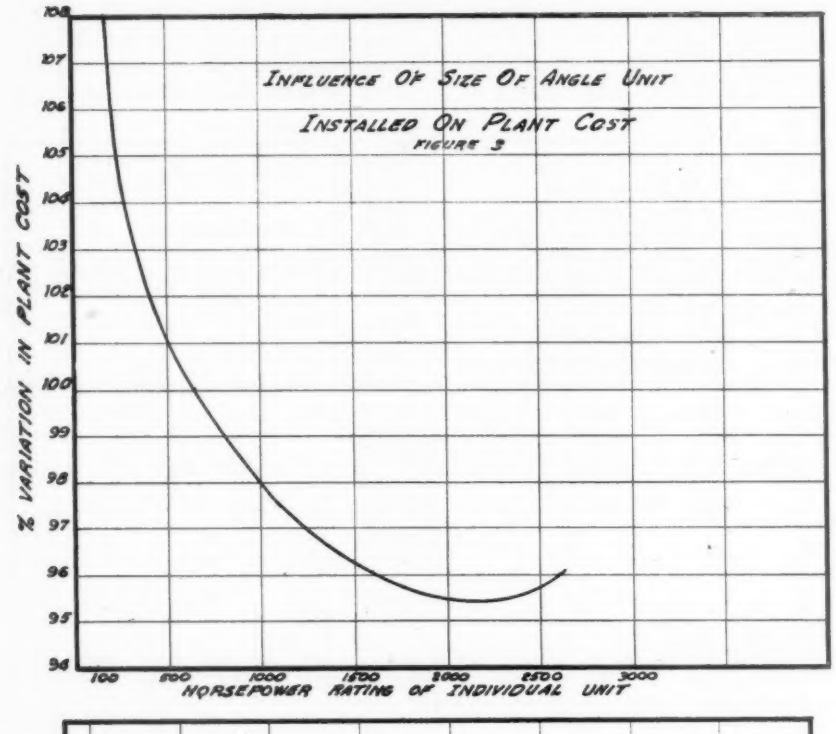
COL.	TYPE	AVERAGE H.P. UNIT	AVERAGE H.P. PLANT	DISCH. PRESS.
A	TWIN HORIZ.	200	1400	500
B	ANGLE	300	2400	500
C	TWIN TANDEM HORIZ.	1000	3000	900
C'	"	1000	4000	900
B'	ANGLE	600	3600	900
B²	"	600	3600	2000
B³	"	600	3600	3000

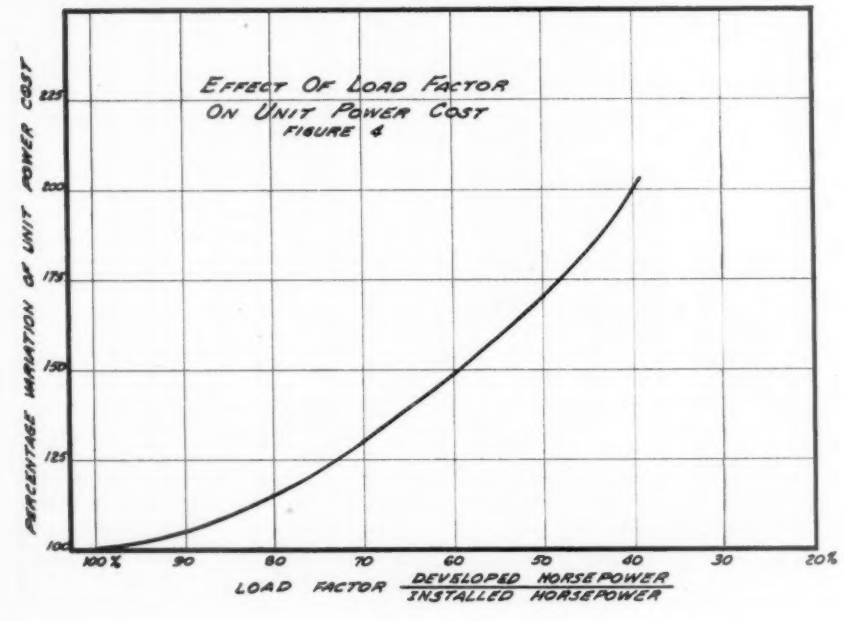
FIGURE 1



*Project manager, The Fluor Corporation, Ltd.







mium of 62 per cent on the added $44 investment. This does not imply that the plant refinements earn this entire premium, neither can it be said that they do not contribute to this economy. The merits of the major refinements will be considered later.

This same earning capacity could pay off the replacement of the older Class "A" plant in 9.25 years. The operating economy between the advanced design plant and the old Class "C" plant could pay for a Class "B" plant in 11.5 years. These statements are not intended as a conclusion but rather a substantiation for the advanced design plants. The fact that the Class "A" engines have been obsolete for some 10 years and less than 40 of the Class "C" engines are being manufactured each year further confirms this point.

The plant costs given in Tables 1 and 2 are based on an average of four similar plants. All superfluous equipment and buildings, such as water wells, electric generators, access roads, cottages, offices, and repair shops have been excluded. By including such features, brick buildings, heavy labor premiums as experienced in some isloated locations and particularly in plants containing a small number of engines, the plant unit cost may double those reported herein.

Fig. 2 has been prepared to illustrate the influence of the operating pressure on the plant cost. The light step lines represent the demarcation of ASAP flange ratings. Fig. 3 shows the effect of the size of angle or "V" type engine installed per unit cost, presuming a constant unit cost for the engine proper. The up-turned right hand end of the curve indicates the burden of too heavy a package, apparently exceeding the optimum size unit.

Fig. 9 has been prepared from data secured from a current project involving 3 compressor stations containing identical size engines, ranging from 3 to 20 in number in each station. This figure indicates that 17 is the optimum number of units in a given plant for minimum unit cost. The magnitude of this variable is so large that it controls the optimum size unit for a minimum installation cost. It follows then that the optimum size unit for a 10,000-hp plant would be approximately 600 hp, or 6 per cent.

Fig. 4 illustrates the effect of partial loads on the operating expense. This curve will hold for all 3 classes of plants for the range indicated, with or without operating labor. The line fans appreciably at load factors of less than 40 per cent.

Operation Attendance

Operating personnel in the Class "A" plants report an average of one operator per 1200 hp. This varies from

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600 to 1600 hp for California operation. The superintendents of such plants will agree that it requires no more attention and undoubtedly less, to operate the largest sized, 2600-hp Class "B" engine than it does to operate the smaller Class "A" engine. This would increase the operator's effectiveness at least 3 times and possibly as much as 13 times. Table 3 reflects the more conservative ratio of 3 to 1. During the past 5 years, several smaller plants containing 3 or less units have been successfully operated unattended, except for casual inspection every 4 hours.[2,3]

Maintenance

Class "A" plants require 1 repair man per 600 hp. A Class "A" power cylinder wears 0.0030 in. per annum. The crank bearing has an average life of 2 years. Class "B" cast iron, power cylinders will have comparable wear of 0.0013 in. per year. The honed, chrome-hardened, cylinder liners further reduce the wear to 0.0004 in. per year. Similar improvement has been experienced in bearing services, etc. The accumulative effort of such factors enables 1 repair man to maintain 1400 to 3600 hp in Class "B" plants.[3,4]

Fuel

The peak fuel rate of 10,000 net Btu per hp-hr can be realized on Class "A" and "C" plants. The peak fuel rate of 9000 net Btu per hp-hr was used for the Class "B" studied. Another 12 per cent to 15 per cent reduction in fuel rate can be realized by operating at higher compression.[5] The fuel rates used herein were corrected for load factor, 10 per cent was added to obtain gross heating value and 5 per cent added for auxiliaries.

Lubrication

Class "A" engines and compressor cylinder lubrication requires one-half gallon of oil per horsepower-month. This is equivalent to 1500 hp-hr per gal, or 3.3 gal per day per 200-hp unit. Class "B" units will average 1 quart of lubricating oil per hp-month; 3000 hp-hr per gal, or 5.5 gal per day per 660-hp unit. There have been reports of satisfactory lubrication with one-third of this quantity. But until lubricators can be developed that will dependably meter smaller drops of lubricant, the operator can ill afford to economize on this item.

The lubrication system of the Class "B" has a second function of absorbing some 500 Btu per hp-hr from the power piston and bearings. These engines will circulate from 12 to 18 gpm of oil per 100 hp, picking up 12 to 19 F in temperature. The system includes a sizable oil cooler. It is good practice to return the oil to the engine at a

FIG. 5. Exterior view of 1931 Class A plant.

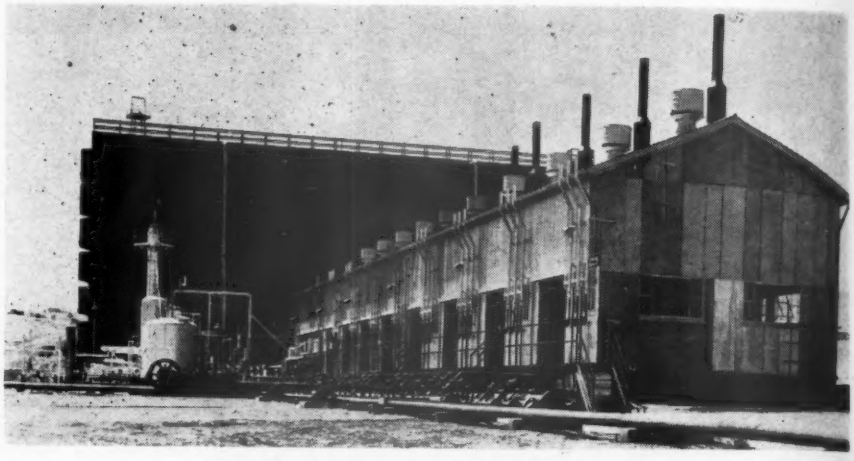


FIG. 6. Exterior view of 1941 Class B plant.

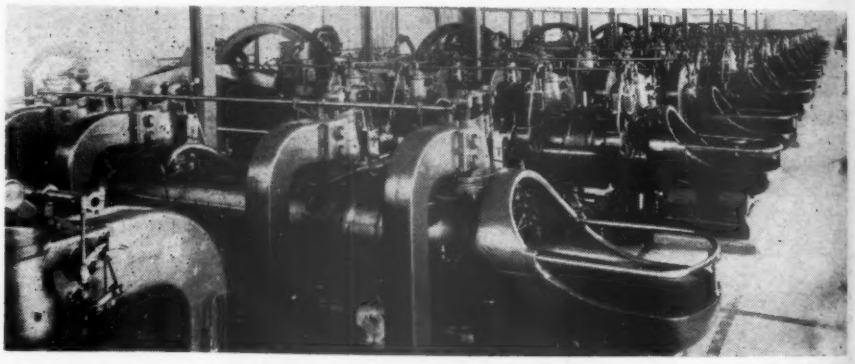


FIG. 7. Interior view of Class C plant.

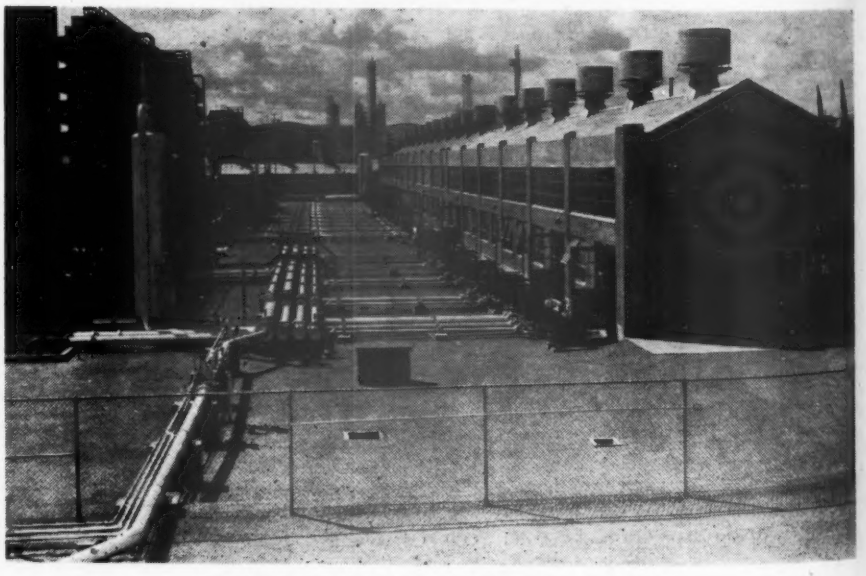
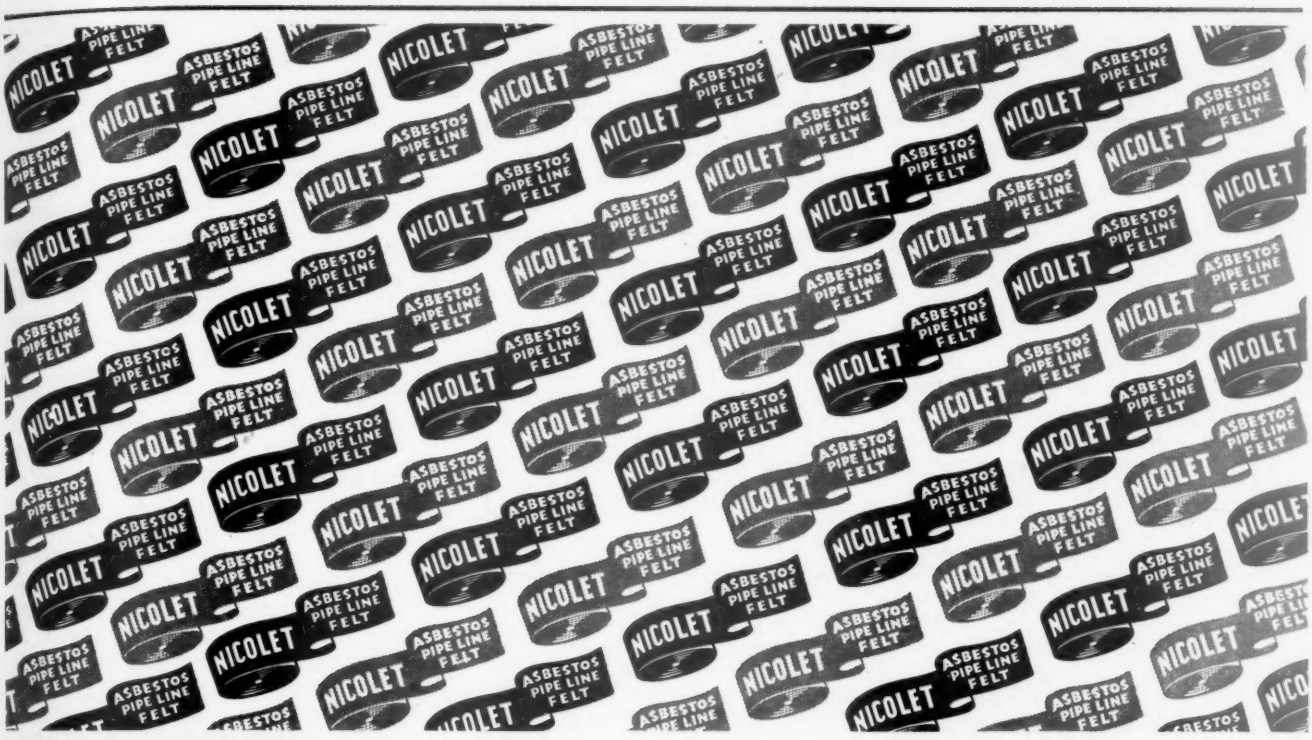


FIG. 8. Exterior view of 1951 Class B plant.



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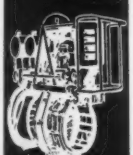
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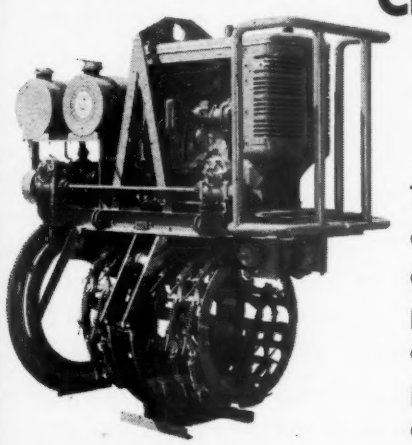

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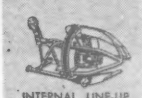
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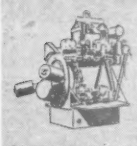
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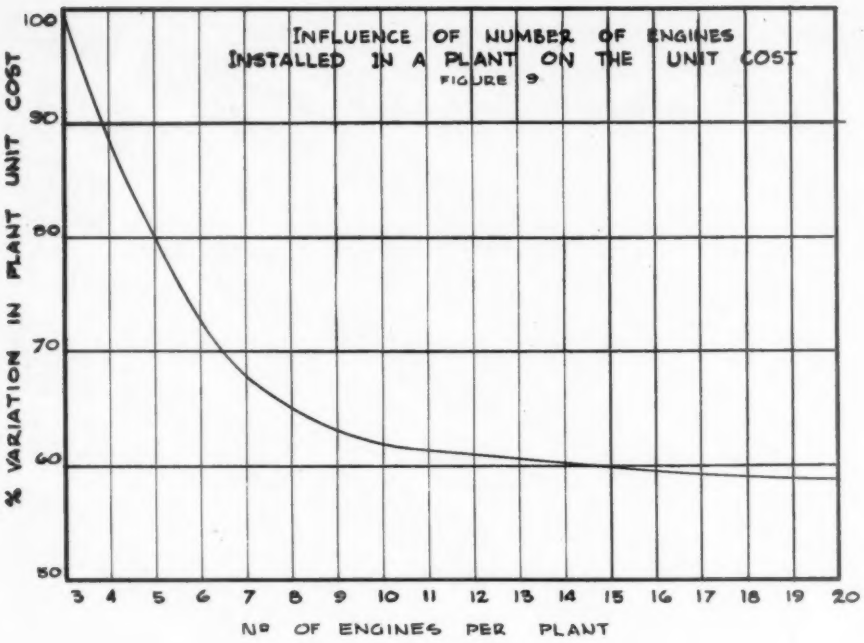
INFLUENCE OF NUMBER OF ENGINES INSTALLED IN A PLANT ON THE UNIT COST
FIGURE 9
% VARIATION IN PLANT UNIT COST
100
90
80
70
60
50
3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Nº OF ENGINES PER PLANT

temperature of 150 F, and especially vital when the bearing pressures are high.

Cooling

Water consumed in the operation of a compressor plant has usually been so plentiful and inexpensive that it was considered trivial. The water consumed in 1931, however, at 1½ cent per bbl, represented as much expense as the repair material. The natural draft, spray type cooling towers used in the Class "A" plants consumed one barrel of water per hp-day. The induced draft cooling towers require only 0.4 bbl per hp-day. A plant with complete air cooled auxiliaries will only require 0.05 bbl per hp-day.

A condensed table of water circulation of a Class "B" Plant is given below:

Facility	Btu/hp hr.	Temp. range	Gpm/ hp
Engine jackets	2600	161 to 150	0.50
Oil cooler	500	155 to 150	0.20
Comp. cylinders	200	154 to 150	0.10
Tower cir. for above	3300	93 to 75	0.37
Tower cir. for gas cooler	1500	93 to 75	0.18

The water consumed is only a portion of the expense incurred in cooling the plant facilities. Cooling water will become as brackish as ocean water unless controlled. Chemical control is necessary to restrict algae growth, delignification, corrosion, and scale formation.[6] Minimum treatment against delignification requires 20 lb of sulphuric acid per day per 1000 gpm of tower circulation to maintain a pH of 7.5. It will require about 75 lb of sulphuric acid per day per 1000 gpm to reduce the pH to 7.0. One of the most satisfactory algae controls is to saturate the circulated water with chlorine or bromide every third day. Such a dosage will require 10 lb of chlorine per 1000 gpm of circulated water. The cost of such treatment, including phosphates and chromates for scale and corrosion control will range from $1.50 to $3 per day per 1000 gpm of circulation. Without such control the cost of descaling and cooling tower maintenance can run as high as 35 cents per hp-month. With chemical control the

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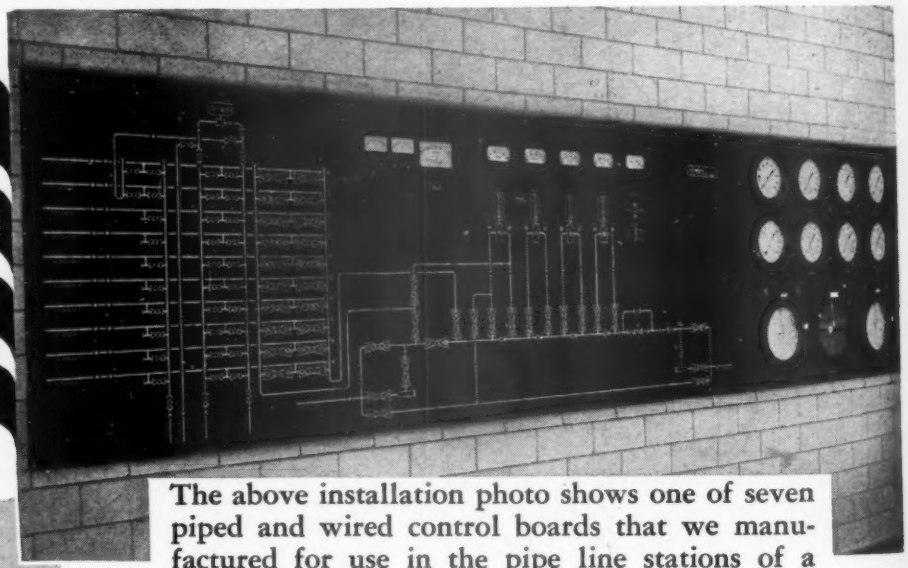

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maintenance can be reduced to approximately 4 cents per hp-month.

Air vs Water-cooled Equipment

The unit costs of air and water-cooled equipment for a plant the size of the Class "B" plant given in Table 3, are shown in Table 4. The operating expenses used in Table 4 are based on the average of the costs given therein and electric power at $6 per hp-month; i.e. 1cent per kwhr. The air-cooled, jacket- water cooler would pay for itself within a year. The air-cooled, gas cooler and the entire air-cooled system would pay out within 2 years. The lube oil can be cooled more economically by the jacket-water system than by direct air cooling as reported herein.

The air-cooled, gas cooler was designed to a 10 F approach to the highest dry bulb temperature. There is an average of 1325 hours per year when the temperature of the air-cooled gas would average 7.3 F higher than the temperature of the water-cooled gas. The remainder of the year the air-cooled gas should be within 2 degrees of the water-cooled gas. Air-cooled, jacket water and oil cooler systems include thermostatic, fan-speed controls.[2]

TABLE 1. Installed unit cost of gas engine driven compressor plants.

No.	Description of items	1931 unit costs Labor	1931 Mat'l.	1931 Total	1941 unit costs Labor	1941 Mat'l.	1941 Total	1951 unit costs Labor	1951 Mat'l.	1951 Total
1	Preliminary excavation grading	2.40	0.50	2.90	3.00	0.75	3.75	6.20	2.05	8.25
2	Concrete	2.05	3.80	5.85	5.15	5.00	10.15	7.25	7.25	14.50
3	Machinery and equipment	1.45	7.70	9.15	2.00	17.20	19.20	4.00	31.00	35.00
4	Piping	6.10	9.15	15.25	7.60	11.45	19.05	11.00	31.00	42.00
5	Building	1.00	2.40	3.40	2.00	4.00	6.00	4.00	8.00	12.00
6	Electrical	0.50	0.70	1.20	0.85	1.20	2.05	2.10	2.70	4.80
7	Painting	0.65	0.35	1.00	0.90	0.30	1.20	2.40	0.80	3.20
8	Steel work	0.35	0.75	1.10	0.70	1.65	2.35	2.40	3.60	6.00
9	Instrument and controls		0.65	0.65		1.25	1.25		1.75	1.75
	Total—direct cost	14.50 (36%)	26.00 (64%)	40.50	22.20 (34%)	42.80 (66%)	65.00	39.35 (31%)	88.15 (69%)	127.50
10	Engineering, overhead, and fees			10.10			16.25			32.00
11	Gas engine—compressor, freight			49.40			57.75			90.50
12	Total			100.00			139.00			250.00
	Class		A			B			B[1]	
	Horsepower per unit		200			300			600	
	Horsepower for plant		1400			2400			3600	
	Discharge pressure		300			900			900	
	Increased cost % over 1931				153	165	161	271	339	315
	Ditto from U.S. Bureau of Commerce				130	115	120	288	195	224
	Excess above Bureau of Commerce, % over 1931				118	144	135	94	174	149

TABLE 2. Installed unit cost of horizontal twin tandem gas engine driven compressor plants.

Item No.	Description of items	1941 unit costs Labor	Material	Total	1951 unit costs Labor	Material	Total
1	Preliminary excavation and grading	4.00	1.15	5.15	7.40	2.00	9.40
2	Concrete	9.20	7.80	17.00	20.20	16.60	36.80
3	Machinery and equipment	2.45	17.05	19.50	8.10	25.90	34.00
4	Piping	6.20	18.95	25.15	11.00	30.00	41.00
5	Building	2.70	4.80	7.50	5.00	8.60	13.60
6	Electrical equipment	1.20	2.70	3.90	2.45	5.00	7.45
7	Painting	1.30	0.40	1.70	2.60	0.85	3.45
8	Steel work	0.40	1.15	1.55	1.40	2.10	3.50
9	Instruments and controls		1.05	1.05		1.50	1.50
	Total direct cost	27.45 (33%)	55.05 (67%)	82.50	58.15 (39%)	92.55 (61%)	150.70
10	Engineering, overhead, fees			20.60			37.70
11	Gas engine—compressor, freight			78.20			133.30
12	Total—dollars per horsepower			181.30			321.70
	Class			C			C[1]
	Horsepower per unit			1000			1000
	Horsepower for plant			4000			4000
	Discharge pressure			900			900
	Increased cost % over 1941				212	168	183
	Ditto form U.S. Bureau of Commerce				221	170	190

TABLE 3. Direct operating expense cost per horsepower—month.

Horsepower of plant		1600	1600	5280	5000	
Horsepower developed		1200	1200	4000	3750	
Horsepower of each unit		200	200	660	1000	
Type of unit		twin horizontal	twin horizontal	angle	twin tandem horizontal	
For year of	1931 unit cost	1931	1951	1951	1951	1951 unit cost
Operating labor	$1.00/hr	0.62	1.50	0.45	0.45	$2.50/hr
Operating fuel	5c/mscf	0.53	1.80	1.59	1.80	17c/mscf
Operating oil	40c/gal	0.20	0.30	0.15	0.50	60c/gal
Operating water	0.5c/bbl	0.17	0.33	0.15	0.33	1c/bbl
Operating electricity	1c/kwhr	0.11	0.11	0.11	0.11	1c/kwhr
Operating supplies		0.06	0.11	0.11	0.11	
Repair labor	88c/hr	0.22	0.65	0.31	0.88	$2.50/hr
Repair material		0.17	0.54	0.20	0.71	
Total		2.08	5.34	3.07	4.89	
Class		A	A[1]	B[1]	C[1]	

TABLE 4. Air vs water-cooled equipment.

	Cost per horsepower Air	Water	Operating expense per horsepower—month Air	Water	Annual earning air
Jacket water	$ 4.55	$3.20	$0.024	$0.152	122%
Oil cooler	2.65	1.25*	0.013	0.033*	18%
Gas cooler	4.15	2.85	0.057	0.114	52%
Total	11.35	6.75	0.094	0.292	52%

* Adjusted for reduced size.

Compressor Cylinder Cooling

The heat absorbed by the jacket-water in the compressor cylinders may be expressed.

$$\text{Btu/hp hr} = \frac{}{100\sqrt{\text{Ratio of Compression}}}$$

This empirical formula was developed from tests which also indicated that the jacket-water temperature of 75 F, with 1 F differential, to 210 F had no measurable effect on the power of compression. Subsequent experience with hot compressor jackets, especially in handling "wet" gases, have been most satisfactory as far as mechanical service is concerned.[9]

Pulsation Dampeners

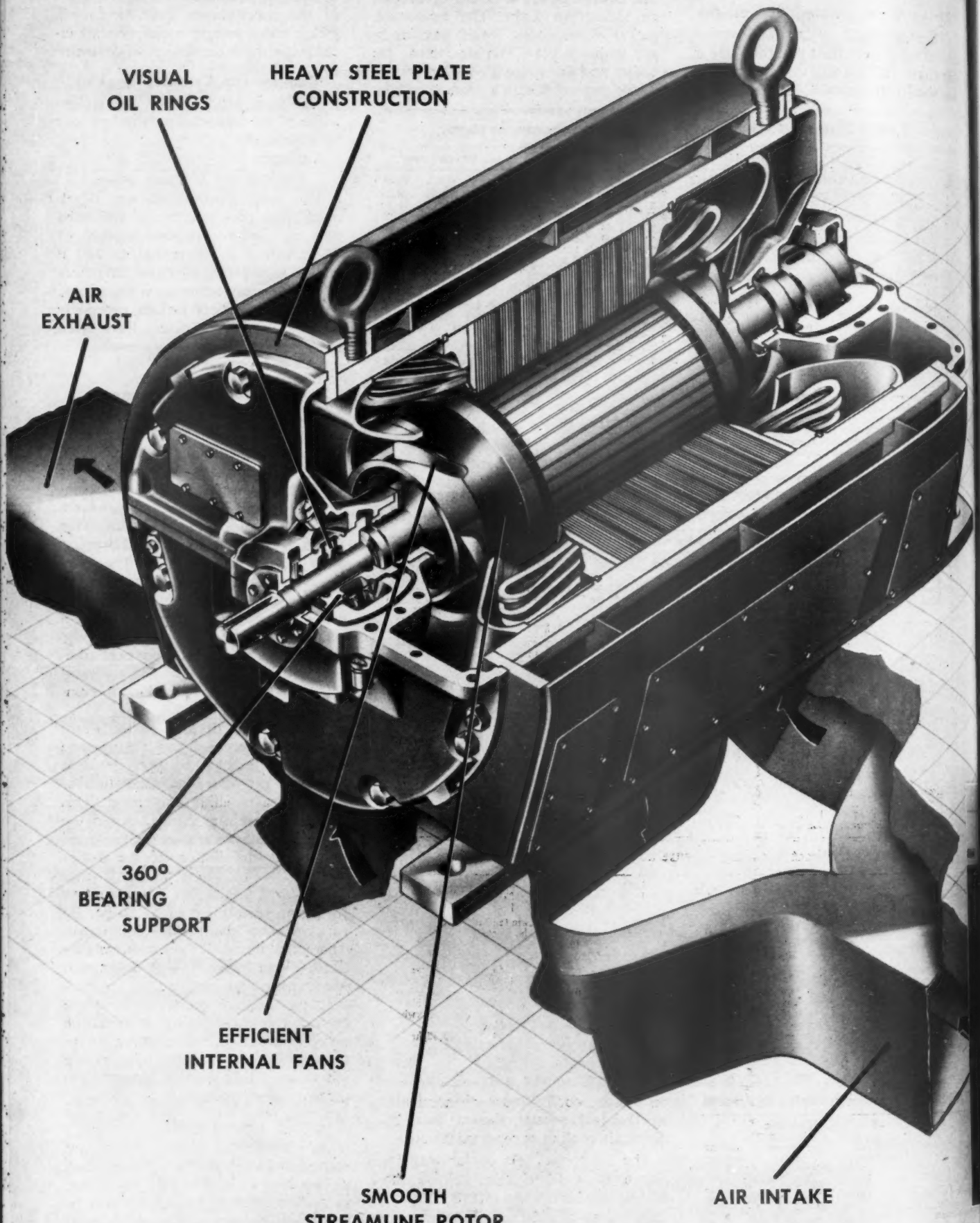
Pulsative flow was recognized 20 years ago as a nuisance to orifice meter gas measurements. In August, 1935, the Gas Compressor Committee of the California Natural Gasoline Association undertook several studies of natural gas compression.[9] This included isolation of the power required to pump gas against a pulsative flow. The valve losses were evaluated without interference of other compressors. The same compressor was tested against a pulsative flow at 150 and 300 psig. There was a uniform 1.5 per cent additional power required to pump against pulsative flow over a range of compression from 1.5 to 8.0.

The research division of the Fluor Corporation has observed that in some cases less horsepower was required to pump gas after the installation of pulsation dampening equipment. This decrease in power depends upon the magnitude of pulsations that existed before the installation of the dampeners. The net horsepower savings would have to be only 1 per cent to justify an investment of $2.50 per hp for pulsation dampening equipment. The actual cost will vary with installations. Three recent pulsation dampening systems were installed for approximately one dollar per horsepower more than conventional piping. It should be noted that pulsation dampening equipment is designed to minimize piping vibrations rather than to reduce compressor horsepower.

Starting Air

All engines of this category are started with 250 psig air. The starting air equipment is relatively small and secondary in importance, and may be neglected in design features. It constitutes the most serious hazard in the plant. The lubricating oil carried from

G-E two pole motor typical of construction below 1000 h.p



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A WIDE SELECTION from General Electric's complete line of pipe-line motors assures you of getting the right motor for every application. For more information on G-E enclosed base-ventilated motors or any of the complete line, contact your nearest Apparatus Sales Office. *General Electric Co., Schenectady 5, N.Y.*

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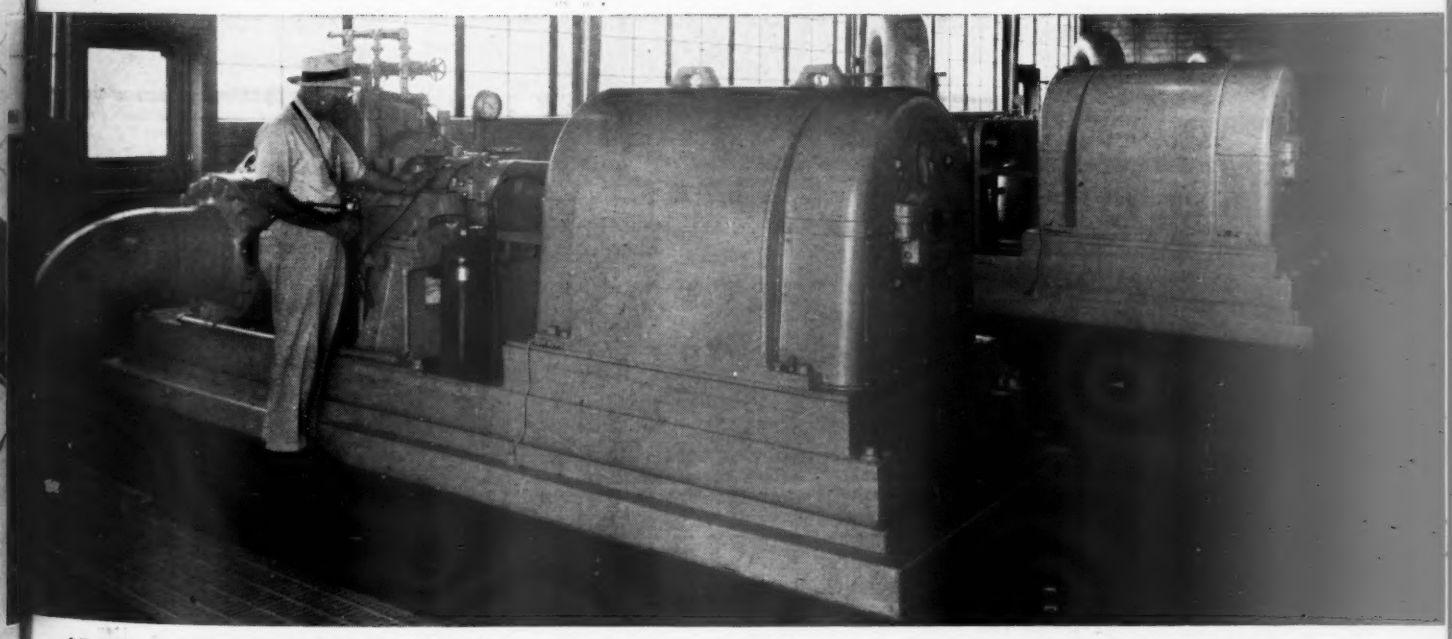

AT THE MODERN ELDORADO STATION in the Rancho Pipe-line System, G-E enclosed base-ventilated motors drive single-stage and two-stage pumps. Air ducts are located below floor level eliminating hazardous leaks from exposed pipe joints.

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the air compressor can be ignited by the compression temperature under adverse mechanical conditions. For this reason some operators will not use the "V" type compressor. Other operators use liquid soap as a lubricant. The 250 psig air should be cooled and scrubbed. The air receiver and headers should be cooled and scrubbed. The air receiver and headers should have a slight pitch. Automatic drain traps should be installed at the low end of the vessel and lines. The unit connection should take off the top of the header and contain a check valve against the engine. These precautions not only contribute to safety, but also aid in starting.[3]

Class "A" engines required 200 to 1000 std cu ft (free air) to effect a start. Another source specified 90 scf per 100 hp to start a Class "B" engine. The air received should be sized to supply 2 starts without the aid of the air compressor or 3 starts with the air compressor within 20 minutes, without reducing the reservoir below minimum starting pressure of 150 psig. These factors can be stated:

Volume of receiver =

$$\frac{2.7 \times \text{hp} - 20 \times \text{D}}{7}$$

Where D is the cfm capacity of the air compressor and hp is the rates horsepower of the single unit in a plant of three or more units.

Mufflers

Political pressure from adjacent residential property owners brought about the modern engine muffler some 20 years ago. There is no tangible economical justification of the modern muffler unless the maintenance was considered on the old water-cooled mufflers illustrated in Fig. 5. These exhaust lines would lime solid in 6 to 9 months. The modern non-cooled, industrial muffler will cost about $1 per hp. The air-cooler muffler will cost about $1.40. Silencing mufflers for residential areas will cost about twice as much.

Air Filters

Many of the operators frowned upon the introduction of air filters for gas engines as another gadget. Engine maintenance was accepted as good honest work. There is little doubt now that air filters extend cylinder life.

Summary

It would be difficult to further account for the referred $44 refinement cost in more detail. Cast iron valves and fittings have been replaced with cast steel and weld fittings. Larger and more efficient scrubbers; automatic and remote controls; and countless other features are now accepted as commonplace. The days of the $100 hp plant, free fuel, and water are gone. Design engineers cannot afford less than the most efficient operating plant.

This is a case history of how one industry has met the changing economy and proved by cost accounting the benefits of applying new developments.

Acknowledgment

This discussion was presented at the ASME semi-annual meeting in Los Angeles, 1953.

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★ ★ ★

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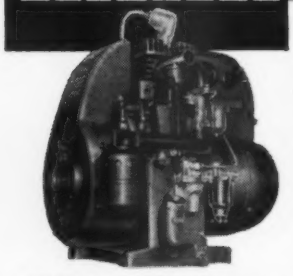

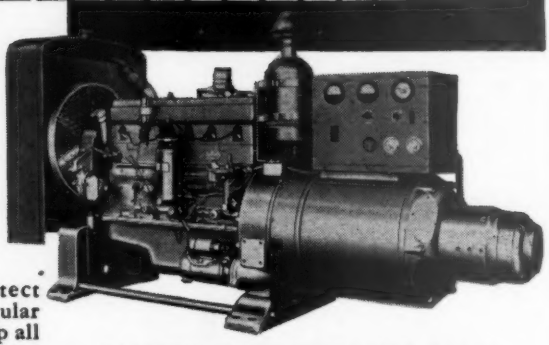

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Air-cooled: 1,000 to 10,000 watts. Powered by one and two-cylinder Onan engines.

Water-cooled: 10,000 to 50,000 watts. Powered by four and six-cylinder, heavy-duty engines.

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MARVEL INVERSE OILER—

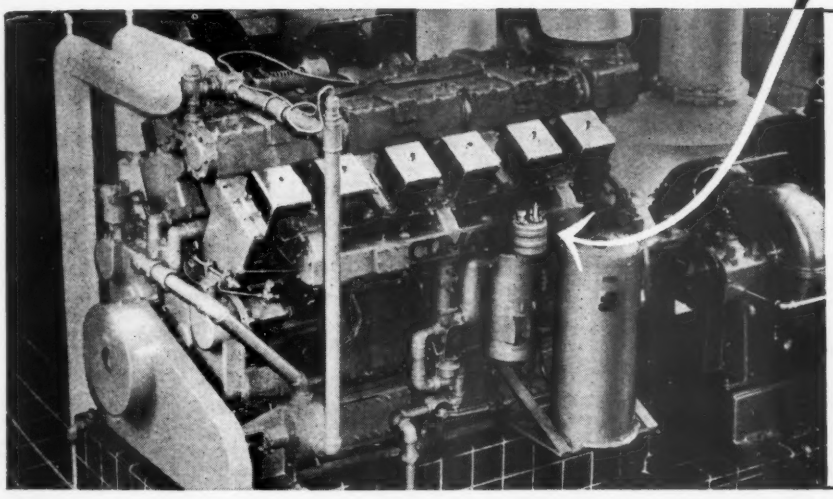
Vital Part of World's Finest Engines

Engine manufacturers think so highly of the Marvel Inverse Oiler they have incorporated it as a vital unit in their engines' lubrication systems.

They have found that engines, equipped with Marvel Inverse Oilers, can be depended upon to give quick acceleration to save trip time . . . keep operating costs to a minimum . . . guarantee hours of continuous performance . . . keep "down-time" low by extending periods between overhauls.

The famous Climax Engines, one of which is pictured below, is an example. A truly fine performer, it is equipped with a Marvel Inverse Oiler for Marvel Mystery Oil—finest performing lubricant of all.

The Marvel Inverse Oiler feeds Marvel Mystery Oil in exact proportion to engine speed and load . . . properly lubricating valves and guides, preventing wear and sticking. Keeps upper piston rings free in their grooves . . . retards ring flutter . . . and cushions ring pounding which can result in ring breakages. Remember, it is the *oil* which must do these things and only Marvel Mystery Oil is blended for this purpose and for this oiler.



The Marvel Inverse Oiler

is an integral part of the Climax 12 cylinder, 171 H.P., 600 RPM GAS ENGINE. Operating off the intake manifold, this completely automatic Oiler feeds Marvel Mystery Oil exactly in proportion to engine loads . . . gives direct protection to the all-important upper cylinder areas.

This Chart shows the proper setting for constant load engines

BRAKE H. P. AT BELT	NAT. GAS CU. FT. PER HOUR	BUTANE GALLONS PER HOUR	GASOLINE GALLONS PER HOUR	M. M. OIL DROPS PER MIN.	M. M. OIL HOURS PER QUART
10	115.	1.07	1.12	4	228
15	172.5	1.60	1.68	6	152
20	230.	2.14	2.24	8	114
25	287.5	2.67	2.80	10	91
30	345.	3.21	3.36	12	76
35	402.5	3.74	3.92	14	65
40	460.	4.28	4.48	16	57
45	517.5	4.81	5.04	18	50
50	575.	5.35	5.60	20	45
60	690.	6.42	6.72	24	38
70	805.	7.49	7.84	28	32
80	920.	8.56	8.96	32	28
90	1035.	9.63	10.08	36	25
100	1150.	10.70	11.20	40	22
120	1380.	12.84	13.44	48	19
140	1610.	14.98	15.68	56	17
160	1840.	17.12	17.92	64	14
180	2070.	19.26	20.16	72	12
200	2300.	21.40	22.40	80	11
225	2587.5	24.00	25.20	90	10
250	2875.	26.75	28.00	100	9
275	3162.5	29.42	31.10	110	8
300	3450.	32.10	33.60	120	7

Chart shows total oil consumption

EXAMPLE:—If you use 805 cu. ft. of dry gas, 7.49 gallons of butane or 7.84 gallons of gasoline, your H.P. is about 70, so adjust oiler to feed 28 drops per minute. You will then receive about 32 hours per quart of MARVEL MYSTERY OIL.

If engine load increases after setting for normal load, oiler will automatically increase its feed, decreasing when load is lessened.

To determine drop count per oiler when more than one is used on an engine—divide recommended drop count by number of oilers.

NOTE: Guarantee on oiler is void if any other oil than MARVEL MYSTERY OIL is used. Some *engines* also carry this guarantee policy.

See Your Local Jobber or Oil Well Supply House

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Pipe Line Projects

Little Inch Conversion Hearing Scheduled

FPC has scheduled a hearing December 6, in Washington, D. C., on an application by Texas Eastern Transmission Corporation requesting authority to retire part of its "Little Inch" pipe line system from natural gas service and to construct new facilities to enable it to continue to provide service as presently being rendered.

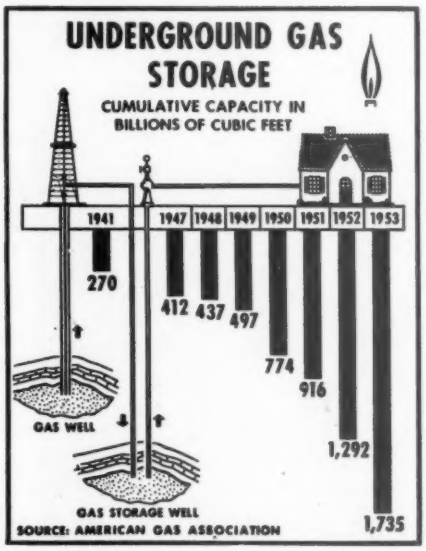
The company is proposing to retire that portion of the Little Inch system located between Baytown, Texas, and Moundsville, West Virginia, and to convert it to the transportation of petroleum products. The natural gas now being moved through the Little Inch system would be transported by means of the new facilitities, which the company proposes to build, together with its other existing facilities.

The proposed new facilities, estimated to cost $71,814,000, would include about 481 miles of pipe line, 86,900 hp in new compressor stations, and 36,020 additional hp at existing stations.

Pipe Line Contractors' LA Program Outlined

The seventh annual convention of the Pipe Line Contractors Association, slated for the Statler Hotel in Los Angeles, California, January 16-19, will be the first group meeting held outside the Southwest. More than 500 are expected to attend, including a number of Canadian contractors.

One session of the meeting will feature a discussion of laws and regulations governing the operation of pipe line construction in Canada, by R. A. MackKimmie of Calgary. Construction methods on 34 and 36-in. pipe will be covered by a panel including Raymond Crowe, chief engineer for Transcontinental Gas Pipe Line; John M. Gay, Associated Pipe Line Contractors, and others to be announced later. F. A. Hough, Southern Counties Gas Company, Los Angeles, will speak on the new code for high pressure gas piping. N. E. Tanner, president of Trans-Canada Pipe Lines, Ltd., will talk on the Canadian outlook, and a panel discussion on safety will be held.



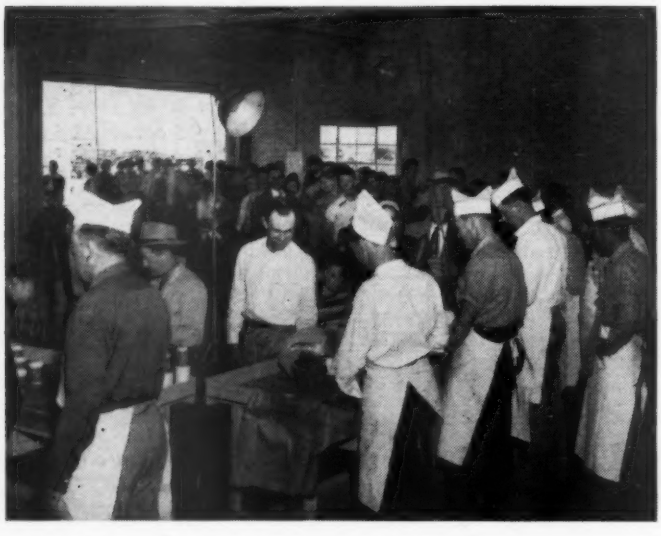
Texas Gas Plans Merger with Two Subsidiaries

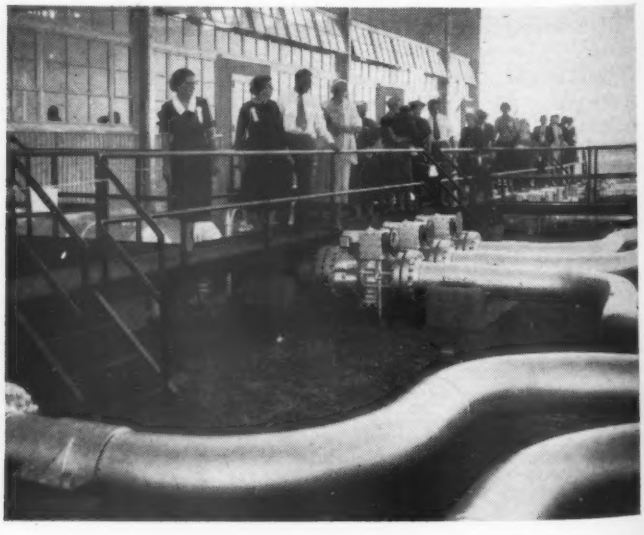
Texas Gas Transmission Corporation has announced plans to file application with the FPC for approval of a merger with two of its south Louisiana gas gathering subsidiaries. The two are Louisiana Natural Gas Corporation and Texas Northern Gas Corporation. Texas Gas acquired Louisiana Natural in 1950. Texas Northern was organized as an operating subsidiary by Texas Gas in 1949. The two companies are primarily engaged in the acquisition of gas reserves in the Louisiana Gulf Coast area.

Pipeliner's Corrosion Short Course Planned

Tentative arrangements have been made by the Houston, Texas, section, south central region, NACE for a short course on corrosion for pipeliners at the University of Houston on January 20-21, 1955. General chairman for development of the program is C. L. Woody. The short course will be designed to provide superintendents, foremen, and operating people with practical information on the elementary theories of corrosion, its control internally and externally, cathodic protection, and related subjects.

More than 15,000 persons living in areas adjacent to compressor stations on the new Gulf Interstate Gas Company's 1160-mile $125,000,000 system, took time out recently to visit the GI facilities in a series of open houses prior to the beginning of operations. Well attended, the move was a part of Gulf Interstate's program to establish good relations between its employees and the local residents. Visitors at each open house were briefed on the firm's operation, taken on a tour of the plant (right photo), and treated to hot dogs and soft drinks (left photo). More than 25,000 hot dogs and soft drinks were served to visitors touring the plant.





Texas Eastern Completes One Line, Second Underway

Construction of facilities of the Texas Eastern Penn-Jersey Transmission Corporation gas pipe line has been completed and the system, costing $28,000,000, is in operation. The 265-mile, 24-in. line carries stored gas from the Oakford, Pennsylvania, storage field to Lambertville, New Jersey.

Work on a second line, a 58-mile, 16 and 20-in. link of Texas Eastern's Big Inch and Little Inch systems is underway between Joaquin and Longview, Texas. It is expected to be in operation by January 1.

Esso Terminal Dedicated

A new pipe line terminal with a storage capacity of nearly 1,200,000 bbl has been placed in operation at Waltham, Massachusetts, by Esso Standard Oil Company. The new terminal completes a $23,000,000 expansion program by the company in the New England area. At the terminal, which occupies a 23-acre tract, the 20 storage tanks will be painted green to achieve landscape harmony. Products stored will be received from the company's Everett, Massachusetts, refinery through the Massachusetts Products Pipe Line. Some 40 communities will then be served through tank truck.

Montana Power Asks Permit To Import Canadian Gas

Montana Power Company, Butte, Montana, has applied to the FPC for authority to import natural gas from Alberta, Canada, to supplement supplies available to its pipe line system which serves markets in Montana.

The company proposes to import gas produced from fields in the Pakowi Lake area in southeastern Alberta. The gas would be produced or purchased by Canadian-Montana Gas Company, Limited, a wholly-owned subsidiary of Montana Power. It would then be delivered to Canadian-Montana Pipe Line Company, another wholly-owned subsidiary, which would make delivery to Montana Power through existing facilities at the U.S.-Canadian boundary.

FPC in February of 1952 authorized Montana Power to import up to 40,000,000 cu ft of gas daily and a maximum of 10 billion cu ft of natural gas annually from Canada, to be used exclusively to render service to the Anaconda Copper Mining Company. That authorization expires April 7, 1956.

Montana Power said that the Alberta Petroleum and Natural Gas Conservation Board recently issued a new 20-year permit to Canadian-Montana Pipe Line Company authorizing the export of a maximum of 100,000,000 cu ft of gas per day and up to 20 billion cu ft per year. These volumes include the volumes heretofore authorized. Montana Power has declared that these Canadian reserves "are urgently needed" to supplement its reserves in the United States to supply its over-all system requirements and permit the normal growth and expansion of its system.

Present imports, for use by Anaconda, are produced and transmitted by the two Canadian subsidiaries. Under the FPC's 1952 authorization, Montana Power constructed about 52 miles of pipe line from the Canadian border to a connection with its existing facilities near Cut Bank, Montana. This same line would be used to transport the newly-requested imports of gas.

Stations Moved from Texas to Nebraska

A crude oil pumping station at Palestine, Texas, is being moved from its present location and transported about 1000 miles to a new home near Potter, in western Nebraska, where it will be installed on a 45-mile, 8-in. crude line to be operated by Arapahoe Pipe Line. Tuloma Builders, Tulsa, has been awarded the contract for the moving and reinstallation project by Pure Transportation Company.

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- **ONLY ONE** instrument necessary to make high potential tests for leakage, breakdown or shorts!
- **PORTABLE,** with rugged steel case...Operates in any position!
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- **VISUAL INDICATIONS** from neon lights give positive test results. Audible test indication for leakage also available.
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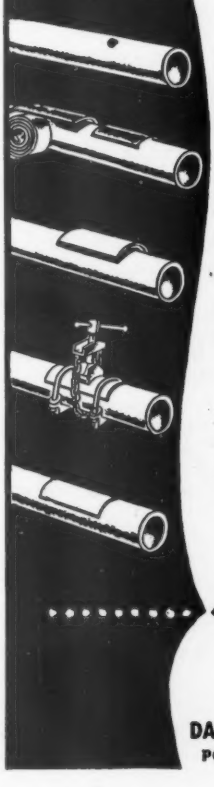

15 Years Exclusive Use by Major Gas Distributing Company—19 Years by Major Oil Companies throughout United States.

1. Regardless of size of leak, just cut GRO-CORD gasket to cover generously.
2. Cut a piece of plate, ready-made half sole or sleeve to extend about 1" on both sides and ends of gasket.
3. Fit plate over gasket so it extends beyond the GRO-CORD gasket on all sides.
4. Clamp repair tight with a chain jack to shut off the leak. With clamps, hold plate in contact with pipe at all points. Weld all around and REMOVE CLAMPS. Clamps may be left until welding equipment is available. GRO-CORD gaskets have been in service as long as 5 years before final weld.
5. Permanent welded repair after clamps removed. Specially shaped GRO-CORD gaskets are used by pipe line companies everywhere. Tested at 1600 lbs. p.s.i., oil resistant cotton impregnated GRO-CORD gaskets last for years.

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PIPE REPAIR GASKETS
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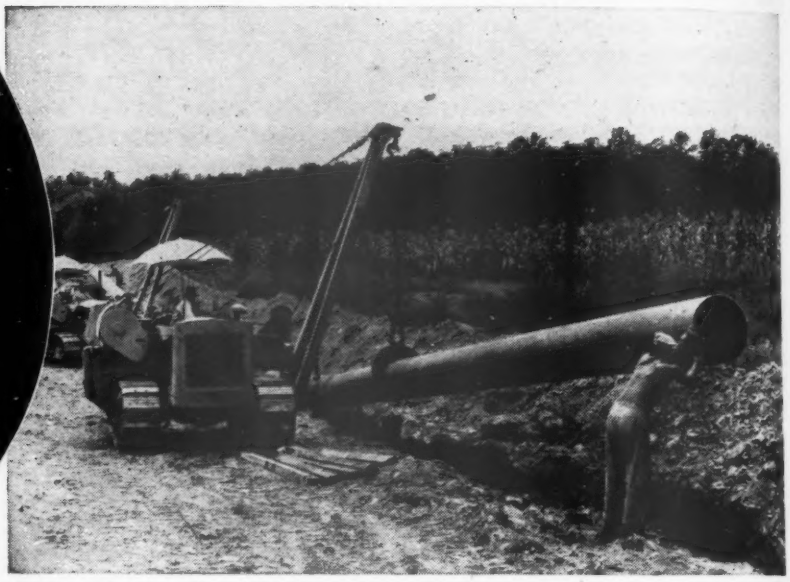
POST OFFICE BOX 7181 DALLAS 9, TEXAS

● *Five miles west of Cushing, Okla., 10¾" Republic Electric Weld Line Pipe being laid.*

3 KINDS OF LINE PIPE ALL FROM REPUBLIC



● *This 24" O.D. Electric Fusion Weld Line Pipe is going in as part of a high pressure natural gas pipe line near Leeds, Alabama.*

Need Big Sizes? Republic makes Expanded Electric Fusion Weld Line Pipe in sizes 24" to 30" O.D. And it goes in *fast*. Circumference is always constant. Field joints line up accurately and quickly. The entire circumference can be welded at top speed. And to further speed field welding, uniform wall thickness provides an even distribution of metal all around the pipe.

From 2⅜" to 16" O.D. you can use Republic Electric Resistance Weld Line Pipe. Its high ductility assures smooth, uniform bends in the field or in the shop . . . without severe wrinkling. Uniform high yield strength permits building high pressure lines. Uniform wall thickness means dependability in every inch of the line.

Continuous Butt Weld Pipe made by Republic has been a standard in the oil fields for many years. It comes in nominal sizes ⅛" to 4" GRL, is used for gathering lines and many other oil and gas handling needs. It has uniform strength and ductility, tight adherence of the galvanized coating, is easily threaded, readily welded and bent.

When you need line pipe for oil and gas transmission, high or low pressure, remember, you can get all three kinds from Republic. Write for literature.

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Republic LINE PIPE

ELECTRIC RESISTANCE WELD • ELECTRIC FUSION WELD
CONTINUOUS BUTT WELD

Short Line, Compressor Plant Requested For Ohio Area

Ohio Fuel Gas Company has applied to the FPC for a certificate authorizing the construction of 10.6 miles of 20-in. pipe line and an 880-hp compressor station to help improve its underground natural gas storage operations in Ohio.

The 10.6 miles of line would be located in Hocking and Fairfield counties, in the company's Benton storage area. Construction of the line would eliminate the restrictive effect of existing transmission facilities and provide adequate capacity for required storage withdrawals. The new compressor station, to be built in Ohio Fuel's Guernsey storage area in Guernsey County, is required for efficient development and utilization of existing storage facilities, the application states. Total estimated cost of the proposed new facilities is $942,900.

NGPLA, Producers Sign Contract; 280-Mile Line Planned

Natural Gas Pipe Line Company of America has signed a $100,000,000 contract with a group of Houston independent oil and gas operators to buy natural gas from the Wise County area in North Texas.

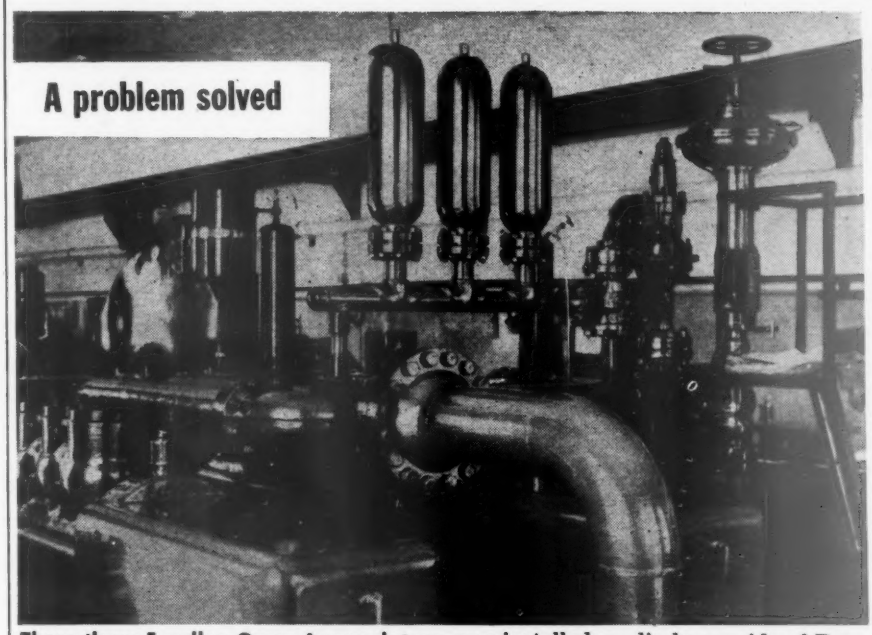
To take the gas, NGPLA proposes to build a 280-mile line from the field through southwestern Oklahoma to a point near Amarillo in the Texas Panhandle where the line would tie in with the company's carrier to Chicago.

A minimum 20-in. line is planned, for a daily capacity of 150,000,00 cu ft. Tentative plans also call for construction of a $1,500,000 natural gasoline plant in Wise County to process the gas before its sale to the pipe line.

The field operators and producers, represented by Christie, Mitchell and Mitchell Company, Houston, Texas, will have to file with the FPC under order 174-A as will the pipe line company. Included in the group of producers are R. E. "Bob" Smith, Houston independent oilman, Waterfield Oil Company, and Riddell Oil Company, both of New York, and a number of Southwestern businessmen.

Terms of the contract call for the gas price to be based on the heating (Btu) value instead of the usual base price method.

H. Merlyn Christie, chairman of the operating group, said the group had completed 32 gas producers in the past 2 years with no dry holes. Production is from the conglomerate zone of 5300 to 6000 ft. Group hopes to have 70 flowing gas wells by January, 1956. Consulting geologists estimate total reserves at about 500 billion cu ft, with potential of 650 billion cu ft.



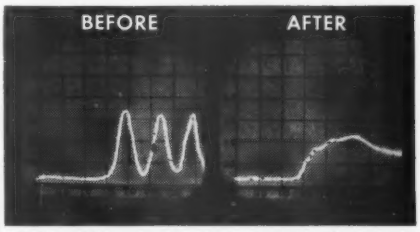
These three 5-gallon Greer Accumulators were installed on discharge side of Prescott double-acting duplex pump. Surge reduction was remarkable. See below.

CASE HISTORY OF PORTLAND PIPELINE PROVES:

Greer Accumulators Cut Pump Pulsations 53%

Oil pipeline and pump breakage were reduced from once a month to zero after installation of Greer Accumulators at pumping stations.

Large pump surges are dangerous. They crack pipelines, break pump barrels, shock engine crank and piston rods into failure. Greer has proved these failures unnecessary.

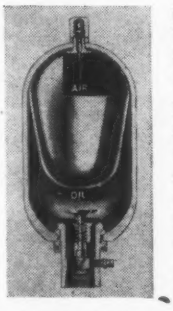


Hydrauliscope photos graphically prove pump pulsations were made harmless resulting in no further line breakage.

Comprehensive tests made at all eight pumping stations of the Portland, Maine to Montreal, Canada pipeline prove that Greer Accumulators will absorb pulses and render surges harmless.

Many pipeline systems—perhaps most—still suffer the costly consequences of these pressure surges. If yours is one of these, we urge you to investigate the simple and certain way to stop this waste.

Our experienced hydraulic engineers will demonstrate the Greer Accumulator to you without obligation. Please call or write.



How accumulator works: When system fluid is forced into accumulator under pressure, the gas in bag is compressed. Thus the rubber bag absorbs impact to an extraordinary degree. Write or call for Brochure 500 that gives detailed data on pump pulsation dampening.

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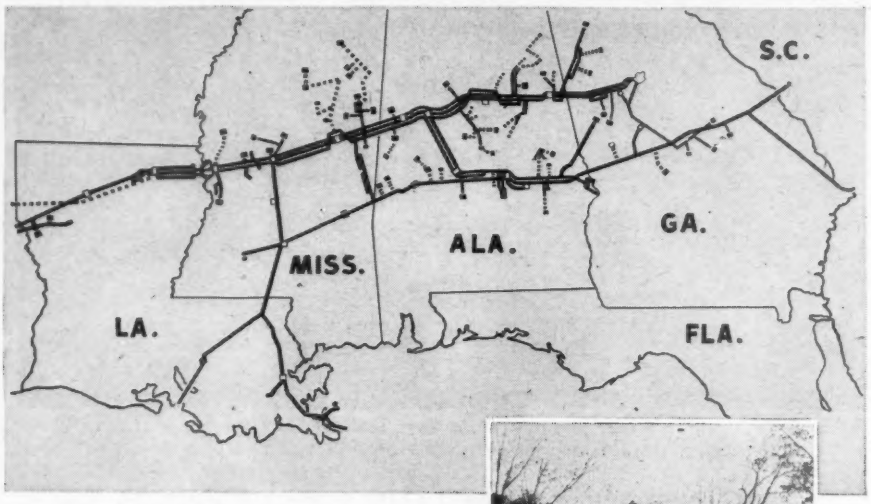
. . . a leader in southern expansion and still growing



MILES OF PIPE

at end of	miles
1947	1899
1948	2120
1949	2218
1950	2625
1951	2840
1952	2970
1953	3855

Glass Fibers Inc. is proud to number Southern Natural Gas Company among its valued customers

GLASS FIBERS INC. congratulates forward-looking Southern Natural Gas Company on its vigorous pipeline expansion program. As is well known, the cost of constructing an underground pipeline is tremendous. The cost of repairing or replacing it is sometimes even greater. Yet, for less than ½ of 1% of the original investment, Blue Flag-reinforced enamels will preserve a pipeline for years beyond its normal life. For a new folder on Glass Fibers' pipe wraps, write to Glass Fibers Inc., 1810 Madison Avenue, Toledo 2, Ohio.

BLUE FLAG

BLUE FLAG PIPE WRAP
DURAMAT OUTER WRAP
DURAMESH PIPELINE FABRIC

GLASS FIBERS *INC.*

Makers of glass fibers by the ELECTRONIC–EXTRUSION process . . . developed, patented and used exclusively by Glass Fibers Inc.

Projects

Trans-Canada Project Facing Tough Obstacles

The proposed 36 or 30-in. natural gas trunk pipe line from Alberta fields to Winnipeg and the international boundary on the way to Minneapolis is still uncertain as to plans or financing. The problem of cost of delivery to the various city utility systems along the route is unsettled with Winnipeg's Winnipeg and Central Gas Company, principal customer on the prairies, unsatisfied about the price at which it could hope to buy at the city gate.

The Winnipeg utility company said it would not undertake to buy gas "blind," as the problem of competition with fuel oil for both domestic and industrial use is severe in this region of low cost fuel oil manufactured from pipelined crude. The Winnipeg company frankly does not expect to take any business away from existing oil burner users until their equipment wears out, as the margin of difference in minimum natural gas selling price, for equivalent Btu value, is not enough to amortize the cost of discarding new or recently purchased oil burning equipment.

Meanwhile, survey work is going ahead on the route of the Trans-Canada Pipe Lines, Ltd., line, under direction of Bechtel-Mannix-Hester, a consultant engineering firm created for that purpose.

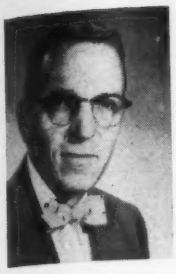
Conoco Line Completed

Work on Continental Pipe Line Company's new 64-mile, 12-in. crude line between Oklahoma City and Tonkawa, Oklahoma, has been completed by G. G. Griffiths Construction Company of Tulsa. The new line, which replaces an older line sold to the Cherokee Pipe Line system for products use, will give Conoco a complete 12-in. carrier between Wichita Falls, Texas, and its refinery in Ponca City.

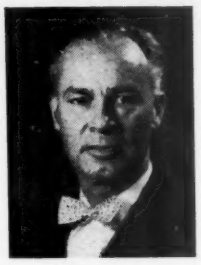
Wyoming-Nebraska Products Line Dedicated

Formal dedication of the 215-mile, 6-in. Wyoming-Nebraska pipe line, new products carrier in the Rocky Mountain area, was held in late November. The line, designed for a maximum capacity of 12,000 bbl daily, will initially carry 8000 bbl between Cheyenne and Sidney, Nebraska, and 6000 bbl daily between Sidney and North Platte. Storage capacity of 51,000 bbl is provided at Sidney terminal and 142,000 bbl at the North Platte Terminal. The line, to be used by Frontier Refining Company, includes an interconnection with Wyco Pipe Line.

Personals



B. E. Francis



E. E. Miller

B. R. Keller

L. W. A. Campbell

Byron E. Francis has been named chief engineer of Northern Natural Gas Company. He succeeds **Martin C. Madsen,** who died September 4. Francis has been with Northern since 1939.

E. E. Miller has been promoted to general superintendent of Tennessee Gas Transmission Company with supervision over the company's compressor, pipe line, gas control, measurement, corrosion control, and communications activities. **B. R. Keller** and **L. W. A. Campbell** have been named assistant chief engineers for TGT, under direction of chief engineer **E. S. Murray.**

W. S. Partner, general superintendent and chief technical advisor for Oleoduto, government-controlled products pipe line of Brazil, has returned to the U. S. after completing a three-year contract. He was an area manager for Service Pipe Line prior to retirement in 1950. **Roy J. Erwin,** station superintendent for Oleoduto, has been promoted to Partner's former position.

Preston F. "Pete" Clark, senior deliveryman at Pan American Pipe Line's Texas City terminal, has been presented an award for developing a tamper-proof bottle and can sealing device for use in pipelining.

Paul B. Rutledge, coordinator of employee activities, Michigan-Wisconsin Pipe Line Company, has been elected chairman of the AGA Midwest Personnel Conference. Other new officers for the coming year include **Armond Harris,** Northern Natural, vice chairman; and **P. S. Hopkins,** Metropolitan Utilities District of Omaha, secretary.

J. D. Davis has been elected a director of United Gas Pipe Line Company. With the company and its predecessors for over 30 years, he is presently superintendent of the firm's western pipe line division.

John Watts, Humble Pipe Line, Midland, Texas, has been elected chairman of the Permian Basin section of the NACE.

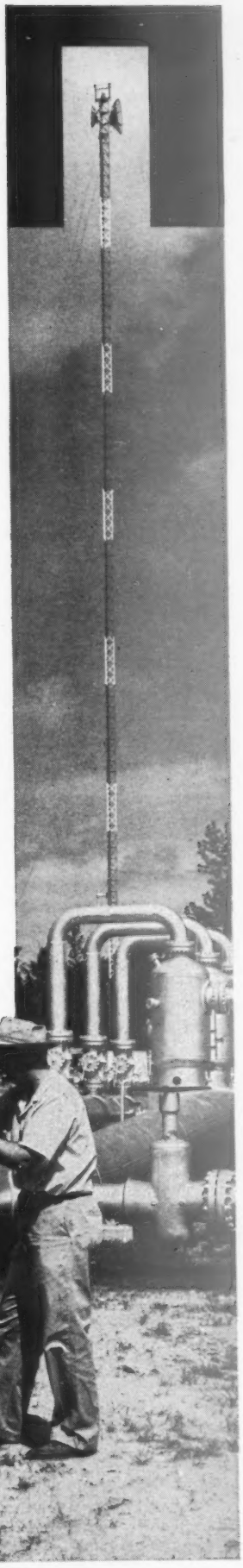
EMSCO's bridle guying assures minimum torsional deflection

For proper microwave operations, the top of the tower must have minimum movement under all weather conditions. The unique bridle guying and superior structural features of Emsco microwave towers assure minimum torsional deflection... minimum maintenance costs.

A pair of guys on each side of Emsco towers are anchored in a reverse direction. If the tower tends to twist because of wind, three of the guys will tighten and hold deflection of the tower top to within 1½°. Conventional guys are used on the lower part of the tower.

Every Emsco tower design meets RETMA specifications and is *unconditionally guaranteed.* Hot dip galvanizing provides protection against corrosion. Bolted construction permits quick, sure visual inspection.

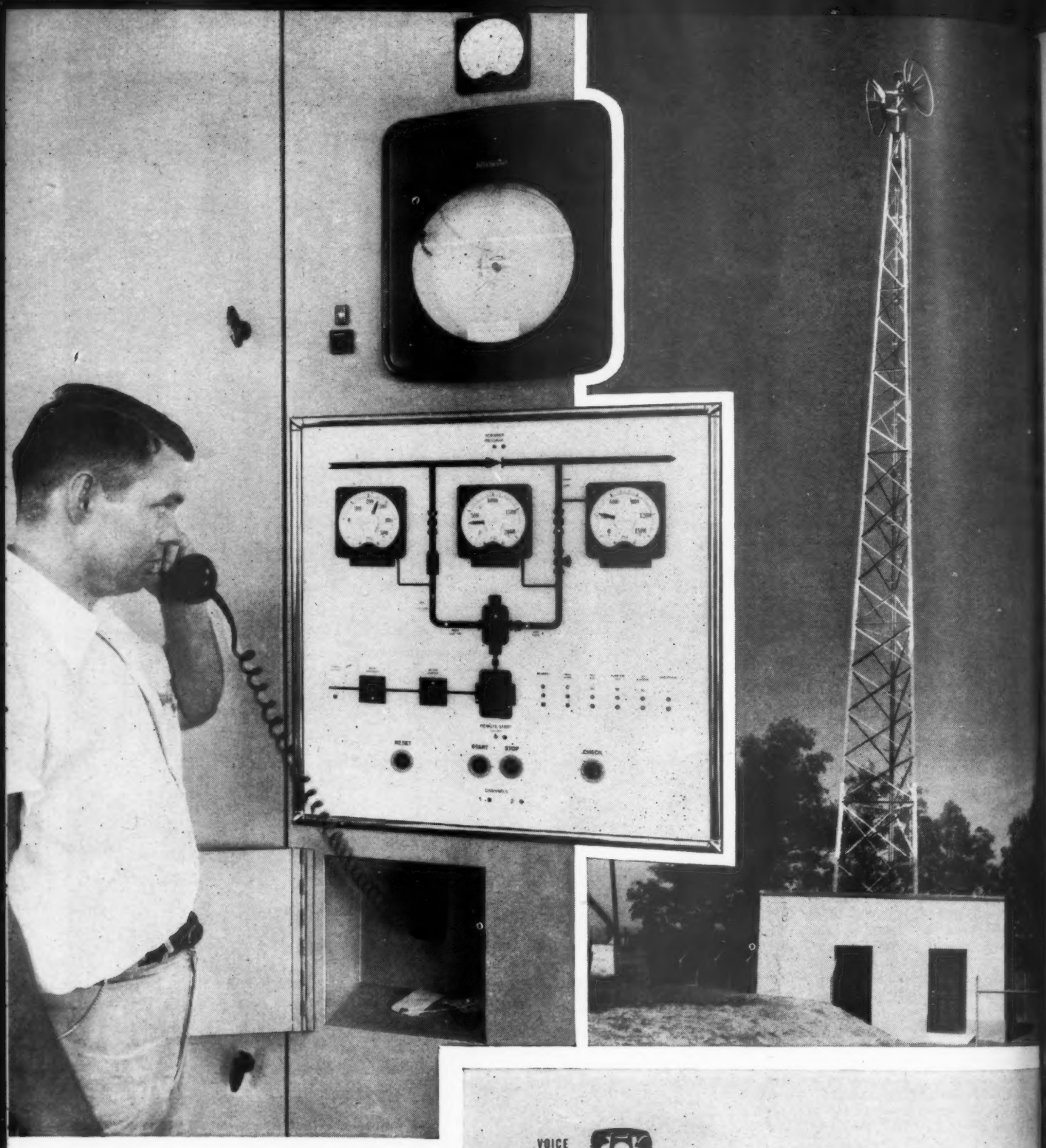
For guyed or self-supporting towers unequalled for safety... structural rigidity... economy... specify Emsco. Prompt delivery is assured.



EMSCO
TOWERS OF STRENGTH
EMSCO MANUFACTURING COMPANY
LOS ANGELES, CALIFORNIA
Houston, Texas • Garland, Texas

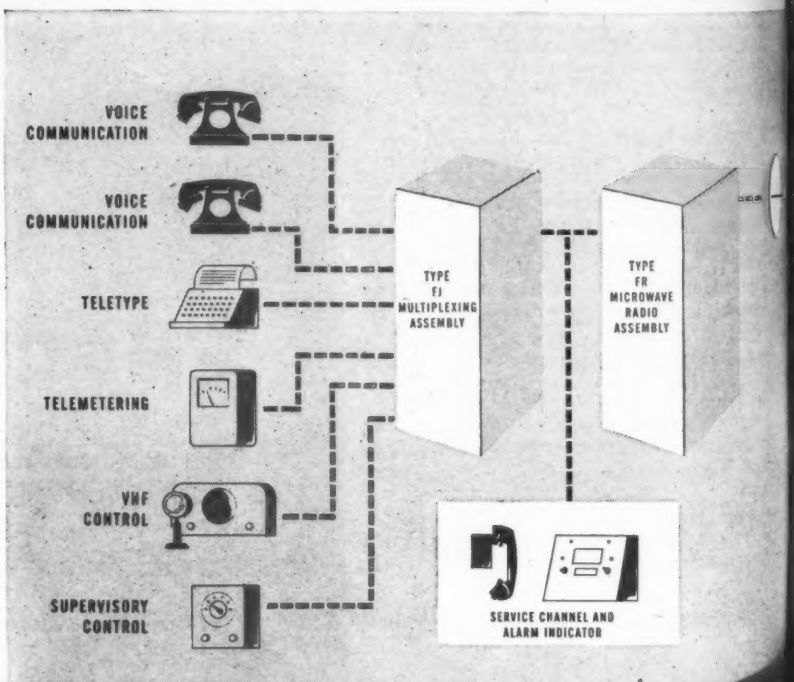
Typical Emsco microwave installation Barton, Alabama

E-184



Westinghouse microwave repeater station and Visicode supervisory control panel are shown here. All visual information and remote controls for a booster station are combined on this single panel. This combination typifies an important service you get from Westinghouse. They can handle your whole project—surveys; design; construction of buildings, towers, all equipment and end-use devices; installation and service—assuring a complete, reliable microwave-control system.

Westinghouse microwave performs a wide variety of pipeline functions, particularly for remote, unattended operation. This multi-channel capability, combined with proved reliability, makes it a sound consideration for your pipeline operation.



Westinghouse 2000-mc Microwave . . . for Pipelines . . .

Communication and control . . . key to reliable, low-cost remote operation

Westinghouse offers pipelines a unique combination of communication and control . . . to meet every requirement for unattended station operation. In one complete system you get reliable microwave communications plus the most advanced telemetering and supervisory control—making a decisive economic partner in efficient operation. Here are the Westinghouse extras which make this possible . . .

• Lowest outage time . . . proved by field service . . .

Every component is tested for reliability, proved during thousands of hours of actual operation—the result of successful installation experience. Maintenance is low, is kept even lower by use of simplified circuitry, built-in test facilities and wide-open construction. Built-in service channel and automatic switchover keep system in service at all times.

• Simplified multiplex equipment makes system changes easy, inexpensive . . .

FJ multiplexing uses independent self-contained panels for highest reliability. Output circuits are designed for easy changing from one function to another. Nothing extra to buy, these panels make changes possible at any time. A minimum of equipment handles all pipeline functions . . . gives more and more opportunity to add services, lower costs.

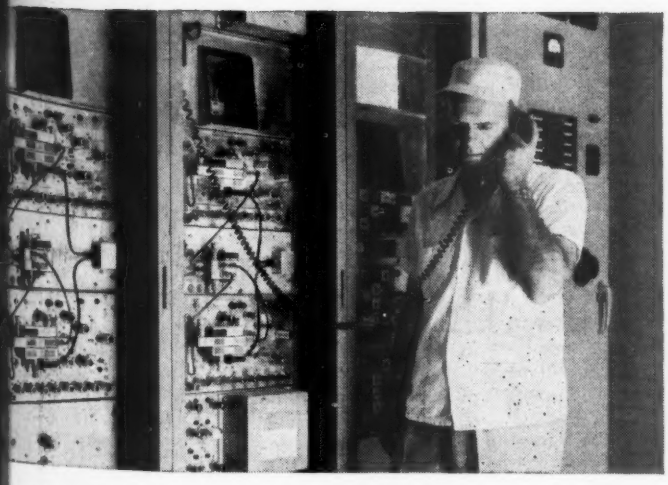
• Complete, specialized control systems . . .

The exclusive Westinghouse Visicode® is renowned as the best system for providing centralized control and visual indications of distant operations. Combined with telemetering and other specialized pipeline control devices, it gives the highest degree of positive remote operation.

These add up to one very special Westinghouse extra . . . the capability to provide a complete, packaged microwave-control system for you. This unique all-in-one service saves you many dollars, delivers the kind of efficiency and responsibility you need to get reliable, low-cost communication and control for your pipeline. For complete information call your representative or write: Westinghouse Electric Corp., Microwave Section, 2519 Wilkens Ave., Baltimore 3, Md.

J-02290

YOU CAN BE SURE . . . IF IT'S Westinghouse



Here is a typical microwave installation at an unattended station. This package includes stand-by radio with automatic switchover—assuring extreme reliability. A total of 30 voice channels is available, each of which can be subdivided for as many as 15 telegraphic functions.

The "eyes and ears" of centralized control are these supervisory relays and telemetering receivers. The Freq-O-Tron* telemetering equipment provides constant intelligence on pressure, flow, tank levels—for use with indicating or recording instruments. The supervisory relays control the Westinghouse-pioneered "automatic check-back" system, a time-proved method for positive remote control.

*TRADE MARK

XUM

CLEANING, COATING, WRAPPING & RECONDITIONING

★

HOT DOPE

Straight from the Kettle on *PIPE PROTECTION*

★

By Boyd Mayes

A while back a couple of us were out hunting and we got caught in a storm that looked like it was going to get pretty bad before it got any better. But we stumbled onto an old shack in the woods that would give us a place to rest out the storm. We got to talking about the feeling of security we got sitting around with the wind and rain blowing outside. Somebody reminded us it wasn't so long ago when a man knew he didn't have any security beyond what he could get with his own thinkin', hustle, and muscle — and luck. And a lot of that luck was like an old darkey on the place used to say, "seems like I always have the best luck with 'taters I hoe the most."

And, you know, it still seems as if about the best chance any man has for security is what he does for himself — and a lot of that is tied up in just doing a job in the right way.

But, now when it comes to gettin' security for pipe against corrosion, we know we can do that right out here at our yard. We've been coating, wrapping and reconditioning pipe — big and little — for over a quarter of a century. We're mighty proud to offer the best of men and equipment to serve you.

MAYES BROS.

1150 McCarty HOUSTON, TEXAS Oil Belt 7166

Personals

D. R. Pflug

R. J. Wallace

D. G. Simpson

D. W. Brown

▸ **D. R. Pflug,** formerly superintendent of operations for United Gas Pipe Line, has been named chief. engineer of Trans-Canada Pipe Lines, Ltd. **R. J. Wallace,** formerly manager of gas supply for Transcontinental Gas Pipe Line has joined Trans-Canada as manager of gas supply. **Douglas G. Simpson** has been named controller and assistant treasurer, and **D. W. Brown** has been named information officer for Trans-Canada.

▸ **Charles Fitzgerald,** vice president and director of Sinclair Pipe Line Company has retired after 33 years service with Sinclair and its predecessor companies. He began his career in 1921 with Humphreys Pure Oil Pipe Line Company of Texas as chief engineer, was general superintendent of the Texas division of Prairie Pipe Line on merger of the two firms, and following the Sinclair-Prairie merger in 1932, has been in Texas since that time.

C. Fitzgerald

▸ **R. F. Sturgis, Jr.,** treasurer of The Pure Oil Company, and **D. R. Williams,** Ohio Oil Company, have been named directors of the Platte Pipe Line Company. Sturgis replaces **J. W. Meehan** of Pure and Williams replaces **J. R. Donnell** of Ohio.

▸ **Lawrence R. Auldridge** has joined the Public Information Bureau of the AGA. He replaces **David F. Grozier,** resigned. Auldridge formerly was with the International News Service in Washington, D. C.

▸ **E. S. Davis** has been named operating manager and **E. C. Hurd** has been named administration manager of Trans Mountain Oil Pipe Line Company. The appointments follow the retirement of **A. F. Terrill** as vice president and general manager of the company. Terrill will remain with Trans Mountain as supervisor of 1955 construction operations in the State of Washington.

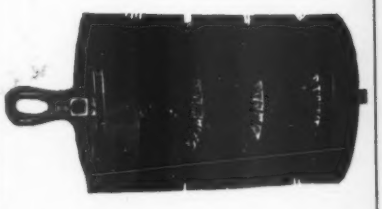
REPAIR LEAKS
QUICKLY — PERMANENTLY

SKINNER-SEAL PIPE JOINT CLAMPS stop leaks at joints. Put on under pressure—without interruption of service. Quick, simple, lasting repair. Sizes 1/2" to 24" incl. in stock.

SKINNER-SEAL COLLAR LEAK CLAMP—designed to stop every type of collar leak in oil and gas lines. Sizes: 2" to 13" inclusive.

M. B. SKINNER COMPANY
SOUTH BEND 21, INDIANA, U. S. A.

MOLE
Pipeline Cleaner



for BETTER cleaning of

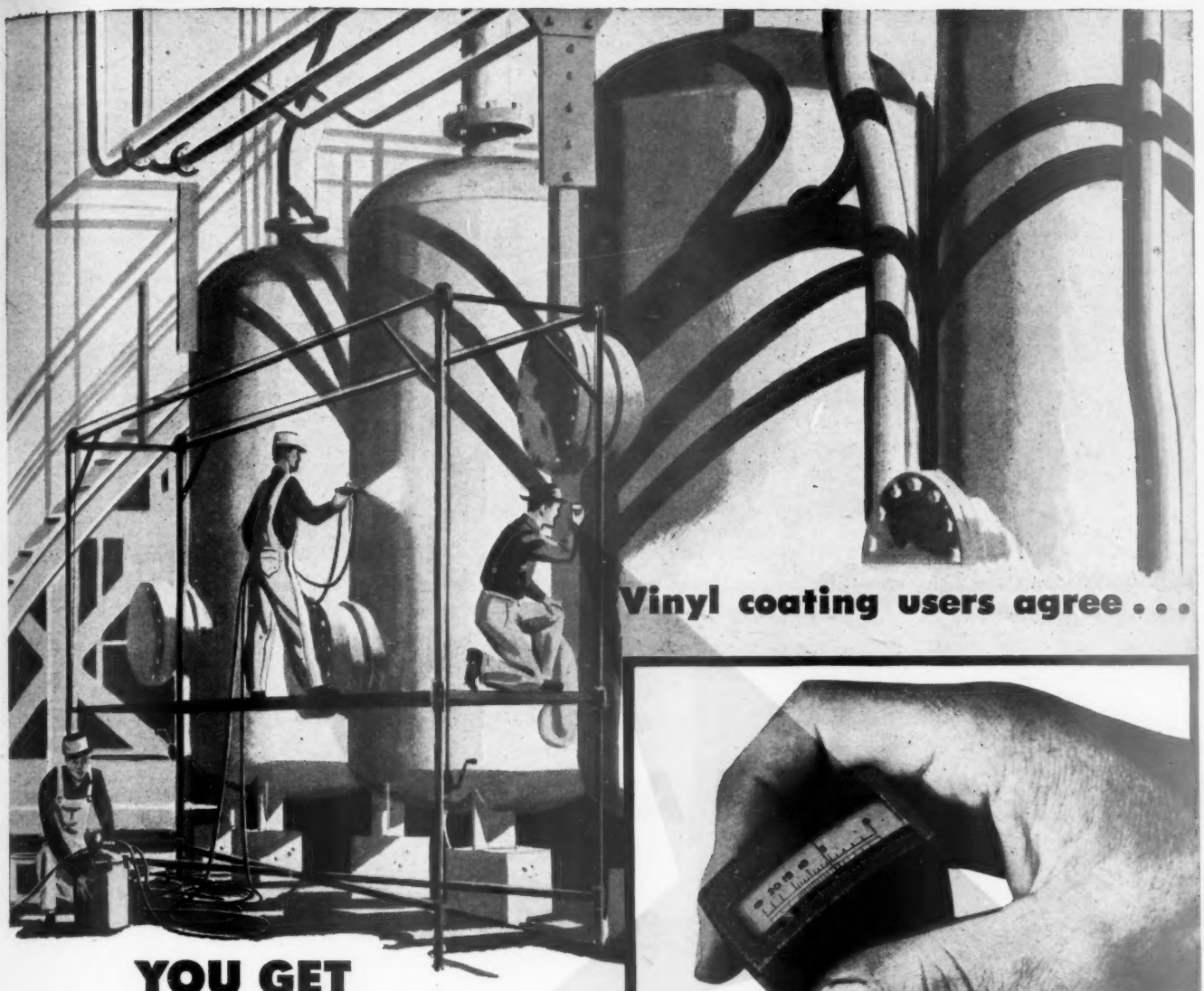
CRUDE LINES

PRODUCT LINES

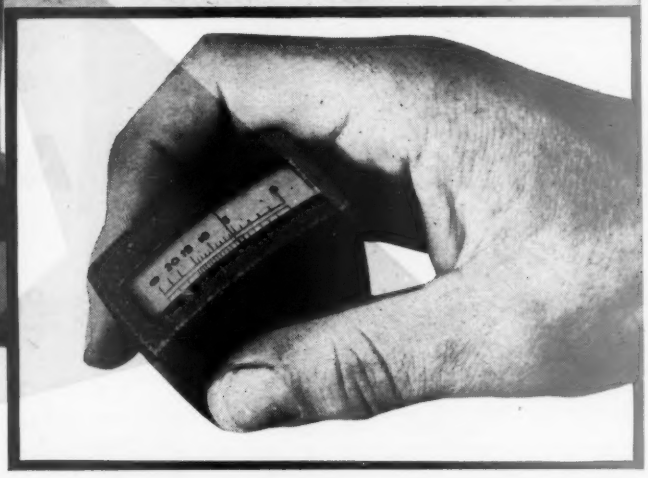
NATURAL GAS LINES

FOR DETAILS WRITE

Pipeline Cleaners Co.
Fort Madison, Iowa



Vinyl coating users agree . . .



YOU GET MORE MILS PER GALLON WITH AMERCOAT 33

Amercoat's higher solids content gives you a thicker, heavier coating—more mils for every gallon applied.

THIS MEANS YOU SAVE MONEY TWO WAYS ON MAINTENANCE PAINTING

Lower Material Cost. You save on material because it takes fewer coats of AMERCOAT 33 to build the required film thickness.

Lower Labor Cost. You save on labor because fewer coats mean fewer man hours for application—less down time, too.

In addition to more mil thickness per gallon, you get more protection per gallon. AMERCOAT 33 is formulated specifically for maximum chemical resistance and for severe weathering conditions. In major industries from coast to coast – chemical, petroleum, pulp and paper, food, and many others – maintenance engineers look to AMERCOAT 33 for low cost, long lasting protection for all types of steel or concrete structures.

Amercoat pioneered the development of protective coatings especially designed for severe corrosion problems. Today it is the only organization that offers you... a complete line of corrosion resistant coatings...nationwide distribution... trained technical men to give you on-the-job assistance throughout the United States and Canada.

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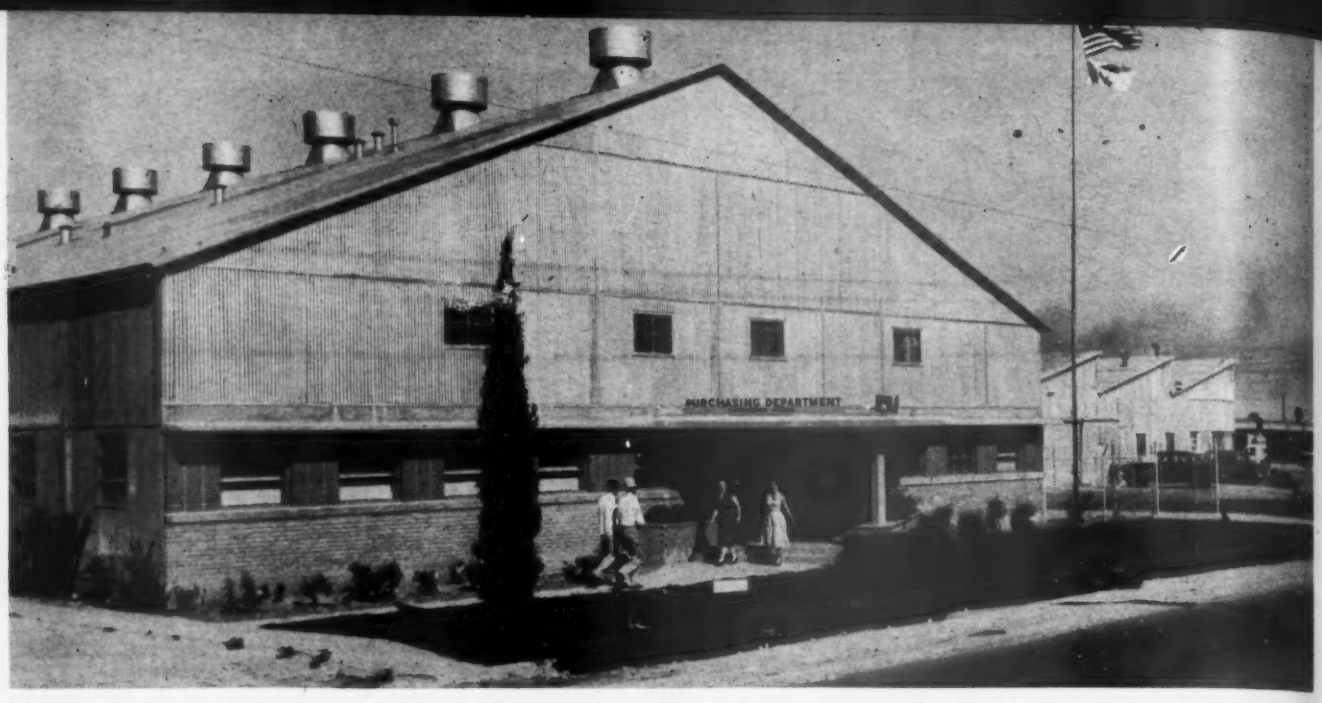
Write today for the AMERCOAT 33 Technical Bulletin which gives a complete description of the coating's chemical and physical properties.



Phillips Petroleum Company's new purchasing department warehouse at Odessa, Texas, is one of three large general field warehouses operated by the company. The new building is finished in blond brick and natural stone.

P 944.21

Pennies Saved Are Pennies Earned†

At Phillips' Odessa, Texas, Purchasing Department Warehouse

PHILLIPS Petroleum Company's purchasing department employees in West Texas are busy each day putting truth into the old saying "a penny saved is a penny earned."

Last year, for instance, these economy-minded warehouse employees began to get rid of slow-moving and obsolete stock items. Next, they moved into a sparkling new warehouse to increase storage space, and started standardizing all materials needed in company operations.

Through this action, Phillips Petroleum Company was able to save several hundred thousand dollars during the year. This is no trifling amount, even when compared with Phillips purchasing volume of over $110,000,000 for the same period.

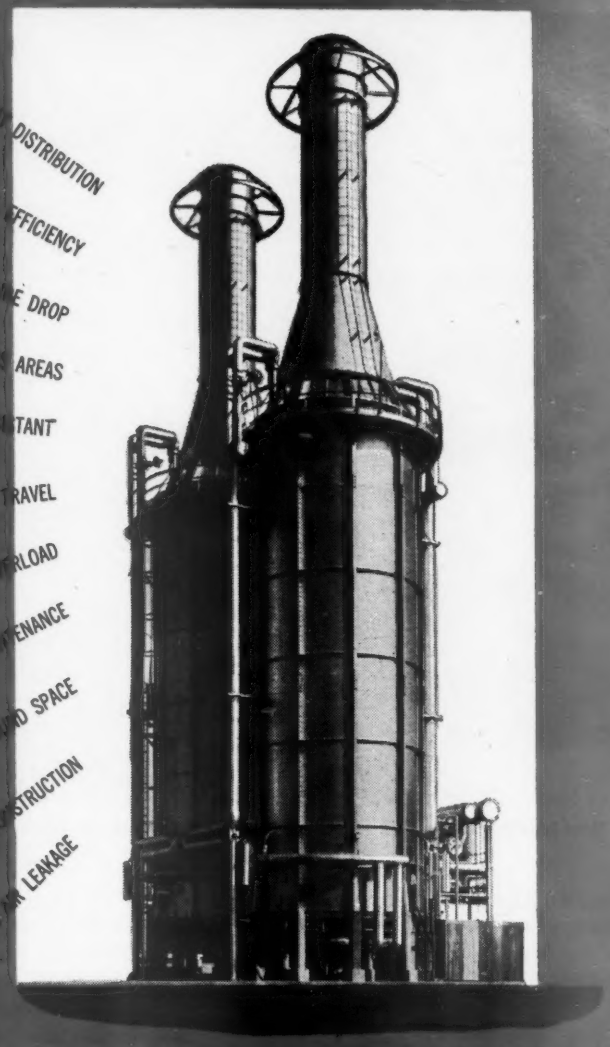
Warehouse Superintendent Herb Rehders is all smiles these days as he goes about checking operations at the new warehouse, pipe yard and salvage shop. "I've got the best looking warehouse and the hardest working bunch of employees in the state of Texas," he drawls. "With the help of this new

An average of 50 area deliveries are made from Phillips Petroleum Company's warehouse at Odessa each day. More than 12,500 transactions were completed there last year.

†Reprinted from Philnews, Phillips Petroleum Company's magazine, issue of July, 1954.

XUM

If yours is a fluid heating problem



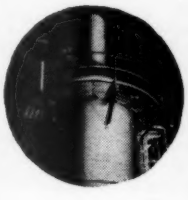
PETROCHEM-ISOFLOW FURNACES

are most efficient by any comparison

MAXIMUM FUEL EFFICIENCY

1. The generic design of Iso-Flow heaters, **including the re-radiating cone,** gives excellent heat distribution and eliminates localized over-heating. **2.** All walls are protected by tubes which create low refractory wall temperatures. **3.** The refractories have high insulating characteristics which create minimum outside shell temperatures and, hence, exceedingly low radiation. **4.** With a radiant loss of under 2% more heat is absorbed by the fluid being heated. This results in higher efficiency for any type of Iso-Flow design. **5.** Since Petro-Chem designs include a wide variety of convection sections all heaters can be engineered for optimum fuel efficiency or for maximum fuel efficiency where the price of fuel and other economic considerations justify.

More than 1200 PETROCHEM-ISOFLOW FURNACES are in operation throughout the world in the petroleum, chemical and allied industries... for all processes and for any duty, pressure, temperature and efficiency ... and all Petrochem-Isoflow Furnaces are pre-eminently satisfactory.



PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE ... CAPACITY ... DUTY

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Representatives: Bethlehem Supply, Tulsa and Houston • Flagg, Brackett & Durgin, Boston • D. D. Foster, Pittsburgh • Faville-Levally, Chicago • Lester Oberholtz, Los Angeles • Gordon D. Hardin, Louisville • Turbex, Philadelphia (Narberth, Pa.)

Foreign Licensees: England – BIRWELCO, LTD., Birmingham 6 • France – HEURTEY & CIE, Paris • Germany – DR. C. OTTO & COMP., Bochum

Truck fleet located at the Odessa warehouse traveled more than 582,600 miles last year.

building, we have been able to increase our storage and working space. This means my boys can now move shipments faster and more efficiently to supply field operations."

West Texas Supply Point

The new, modernistic-looking warehouse is finished in blond brick and natural stone. With its attractive, landscaped grounds, it presents a pleasing addition to Odessa's industrial skyline.

Many hundred different kinds of equipment and materials are stocked in Odessa warehouse, one of three large general field warehouses operated by the purchasing department materials division. But it takes a lot of items to equip completely Phillips' West Texas production, gasoline, and pipe line operations.

In addition, a considerable amount of equipment comes back to the warehouse for reconditioning and stocking. Then it is issued again for use in the same field or transferred to other properties.

New Methods Pay Off

Purchasing, receiving, storing, and issuing materials with maximum dispatch and efficiency are major factors in any successful cost-control program. The Odessa warehouse staff is extremely cost conscious. They are always on the lookout for better methods of stocking, handling and storing the numerous large and small items received there. As a result, improved job techniques have been adopted, time-saving handling equipment has been put into effective use, and warehouse operations have been speeded up.

Standardization on certain types of materials is also effectively used at Odessa. This practice simplifies stocking by permitting repair parts to be switched. In some instances, it has been found the same part may be used in as many as 20 different operations. Figures are proving the value of standardization at Odessa. Unnecessary stocking of duplicate parts and excessive quantities has been minimized.

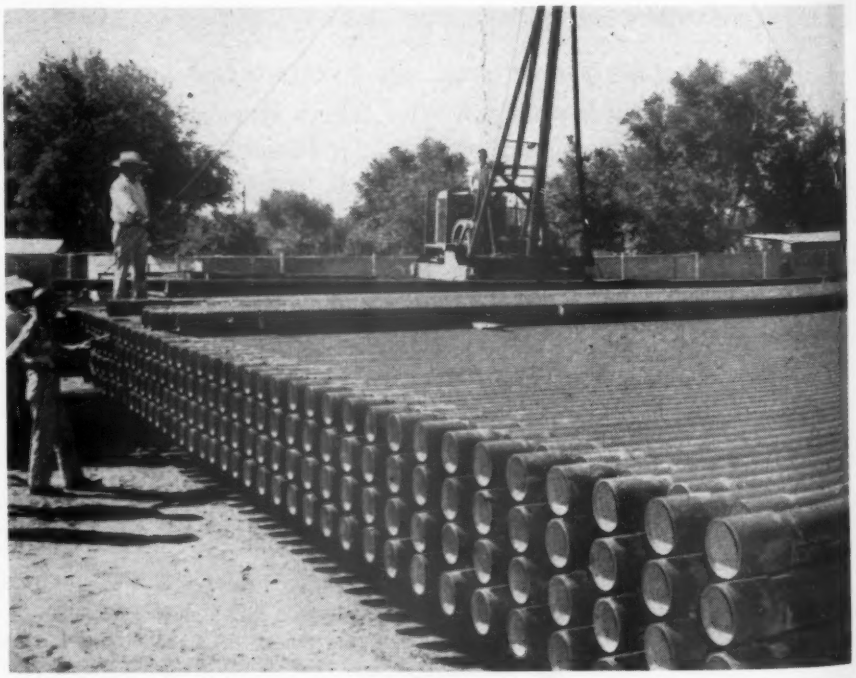
Busy Year

During 1953, 262 freight car loads of materials were loaded and unloaded at this warehouse. Over 6,000,000 ft of new and used tubular goods were handled by the pipe yard and repair shops. During this same period, the Odessa truck fleet operated almost 53,000 hours and traveled more than 582,600 miles.

Years of warehousing experience has enabled Odessa employees to keep the material consumption rate almost equal to material received rate. Consequently, Odessa warehouse acts more or less as a brief stopping point. Materials flow through to points where they are needed in company operations. This explains a busy average of approximately 50 area deliveries each day. It also tells why more than 12,500 warehouse transactions were completed last year at this place.

Drilling, producing, and pipe line shutdowns in the West Texas area due to material shortages have been practically non-existent. When a call comes from one of these departments, our warehousemen deliver the goods in a hurry. But rushed or on routine schedule, these employees pride themselves in keeping the supplies on the move. Best of all, they're sticking to that wise motto for profit-making operations, "a penny saved is a penny earned."

* * *



During 1953, more than 6,000,000 ft of tubular goods were handled by warehouse staff.

XUM

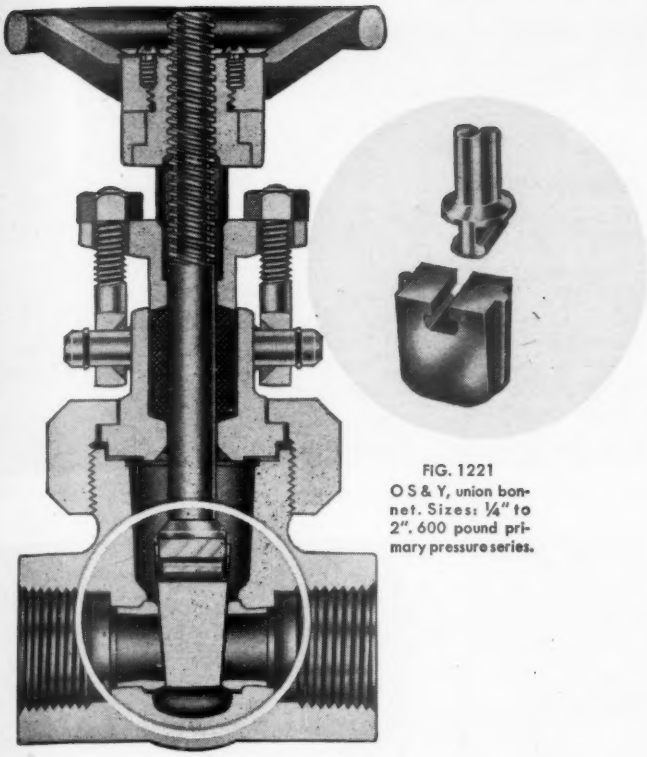


FIG. 1221
O S & Y, union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

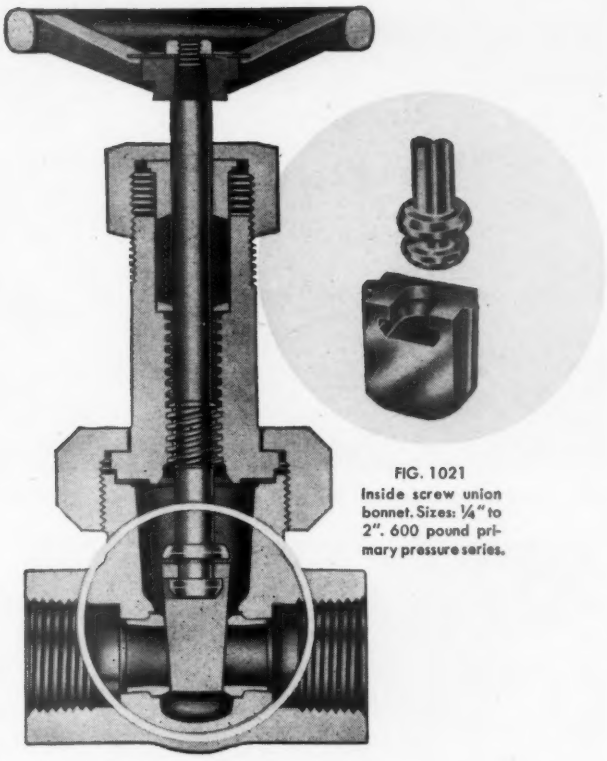


FIG. 1021
Inside screw union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

New design makes OIC forged steel gate valves the most modern line . . .

NEW: stronger stem-to-wedge connection. Improved, modern design increases pull-out strength to many times the theoretical requirement. This design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers in all fields.

NEW: wedges wear longer. Wedges are made of 13% chrome stainless steel for corrosion resistance. They are duracased to at least 1000 Brinell Hardness to prevent galling and excessive wear caused by frequent closures upon foreign particles in the flow.

NEW: union bonnet design is more efficient. Body-to-bonnet joint of the male-female type provides a recess for the gasket. It is contained more securely, reducing the possibility of leakage or a blown gasket.

OTHER OUTSTANDING FEATURES

Stem threads of all OIC inside screw, forged steel valves are always contained inside the bonnet. They can't possibly load up with corrosive matter which might be in the flow. This keeps the threads clean and free running, and contributes to longer stem wear.

Modern OIC Seal-Ever packing is a special composition which eliminates electrolytic action between the stem and the packing. This prevents stem corrosion in the packing area and helps maintain a leakproof seal.

Back-seating feature provides means of repacking valves while in service.

OS & Y valve gland "I" bolts are retained on trunnions by modern, more efficient, stainless steel snap rings.

Shoulder-type seat rings are expanded into the body under heavy pressure. They are accurately machined to mate tightly with the wedge for a positive seal.

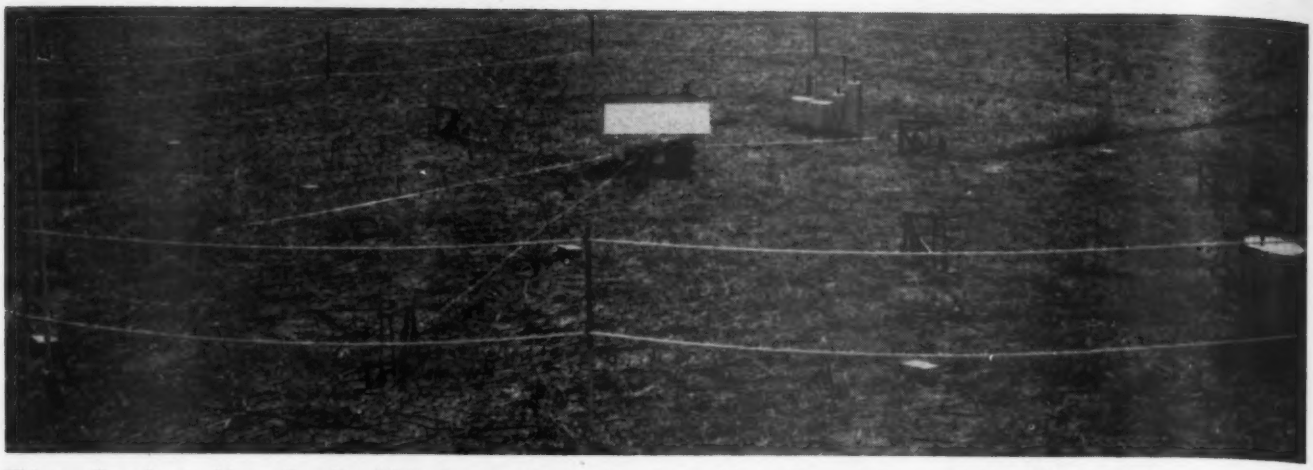
Order modern OIC Forged Steel Valves from your nearby OIC Distributor. Write and request Folder No. 195.

OIC Forged Steel Valves are also available in globes, angles and checks in a variety of trims for any service.

THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO

OIC FOUNDED 1883 VALVES

FORGED & CAST STEEL, LUBRICATED PLUG; BRONZE & IRON



This small scale, working, oil well exhibit, drew much attention from visitors. Pump jacks are eight inches in height.

Maracaibo and supply houses collaborated in furnishing gifts for the estimated 4000 visitors at the exhibit.

Posters explained in simple terms some processes involved in producing oil. Waterflooding was of special interest.

Maracaibo Builds Good Will at County Fair

MARACAIBO Oil Exploration Corporation, Ottawa, Kansas, is recommending county fair displays as an effective means of gaining good will for the oil industry. Although situated in the Kansas farm belt, Maracaibo found a surprisingly strong interest in its oil well exhibit, which was constructed to scale, even to eight-inch pump jacks.

The exhibit, shown at the Franklin County fair, was designed to be of interest to farmers, business men, and even housewives. Through working models and posters, it attempted to explain some processes involved in producing oil, particularly waterflooding. Many of the fair visitors had had experience with oil companies developing their farm lands, but had no knowledge as to how the job was done.

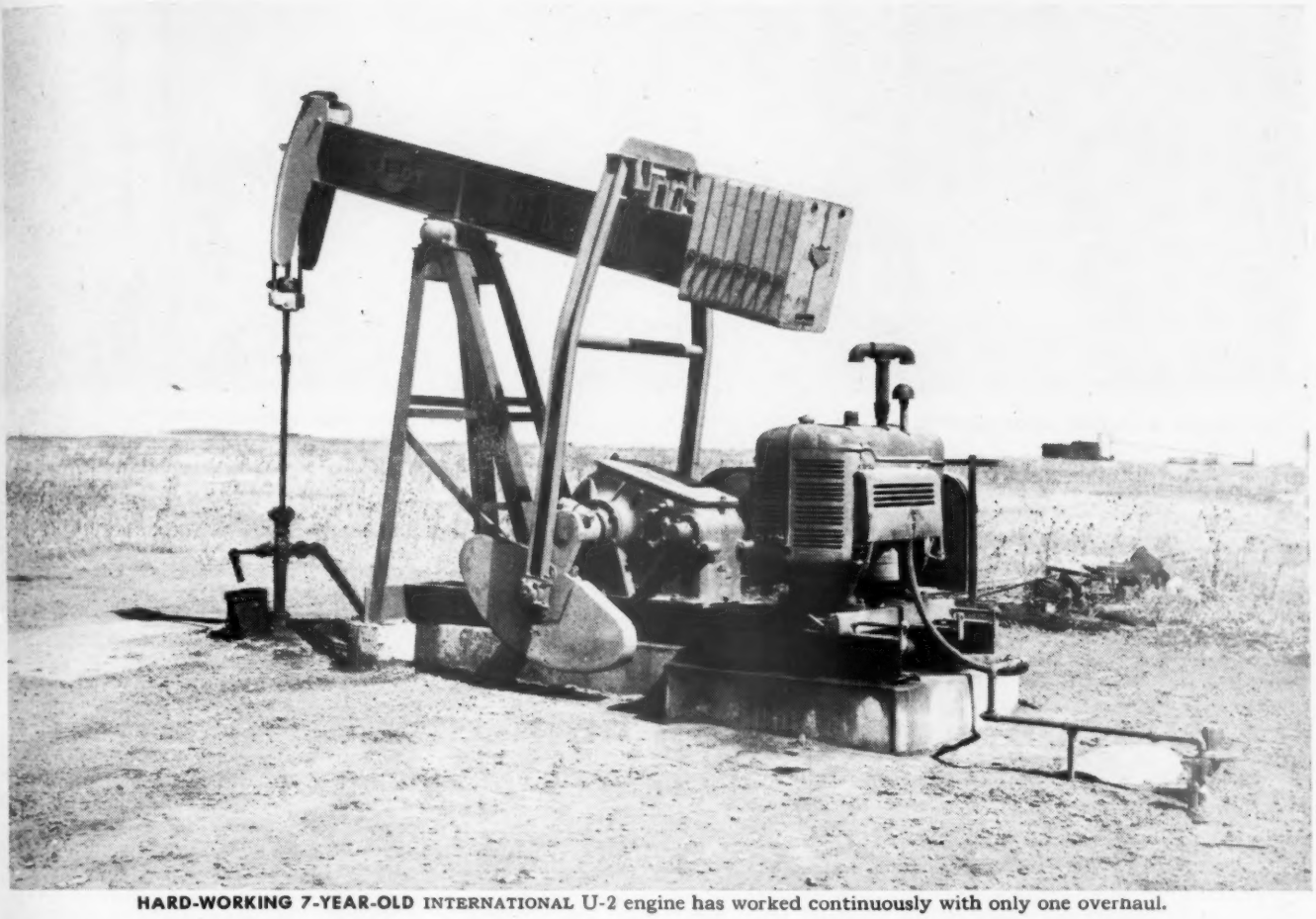
An estimated 4000 persons attended the exhibit during its 3-day showing. Frequent comments showed appreciation of the sponsorship of such an exhibit by a company which actually had nothing to sell except good will.

Each visitor to the exhibit received a memento. Expenses of construction and gifts for visitors were shared by Maracaibo and various supply houses. Kenneth R. Johnson, Bradford Supply Company, and the Ottawa Sinclair agent, Harry E. Murphy, worked with Maracaibo in building the exhibit and supplying gifts.

R. F. Lollar, Maracaibo official, advised that more companies could benefit from patronizing their individual county fairs, rather than sponsoring oil shows for oil people alone. "We have explained to many people some of the problems with which we are confronted and feel that a tremendous amount of good will has been established," he said. * * *

XUM

Runs 7 Years on the Pump Jack with Only One Overhaul



HARD-WORKING 7-YEAR-OLD INTERNATIONAL U-2 engine has worked continuously with only one overhaul.

Rugged IH engine pays off in Pampa, Texas

For over seven years, a sturdy INTERNATIONAL U-2 engine has been working away for Cree Production Co., down in Pampa, Texas.

Pumper H. N. Sanchez gives the low-down:

"These INTERNATIONALS *are tops for oil field work. They sure start easy and run for years and years. This is one of the first U-2s to come out, and it's only had one overhaul in all these years. One thing for sure, these* INTERNATIONAL *engines don't fall apart on the job!"*

On both small and large operations, smooth-running, multicylinder INTERNATIONAL engines have made a reputation for reliability among oil men everywhere.

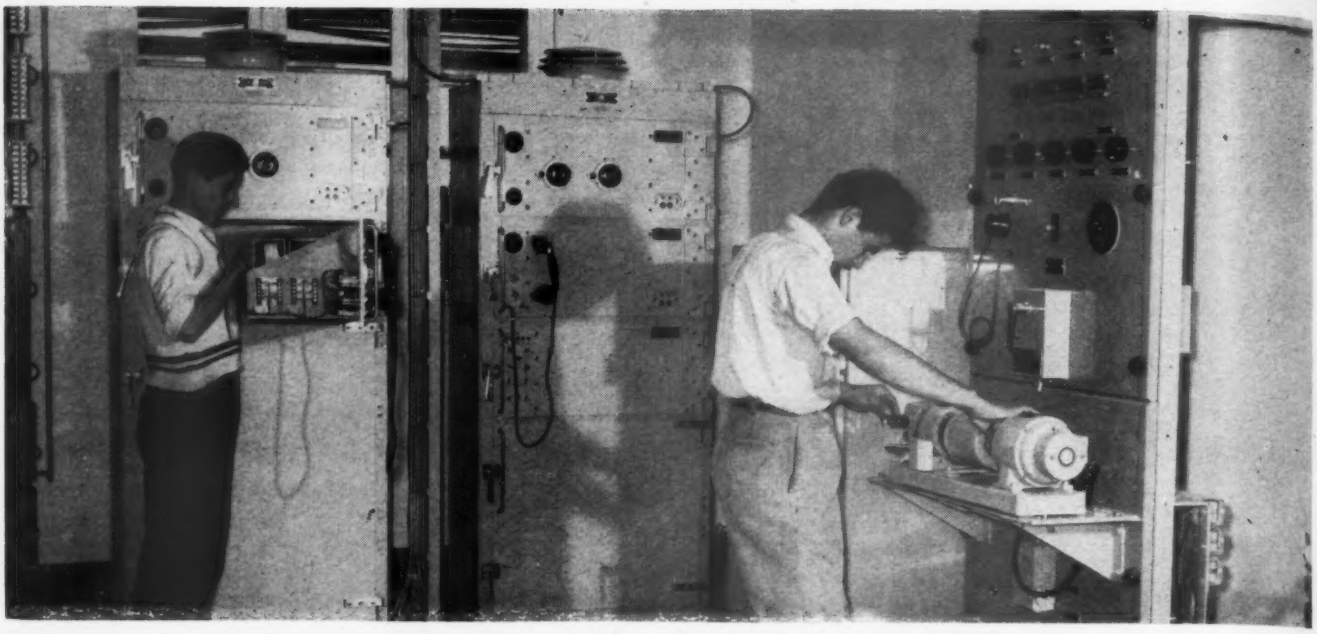
Your INTERNATIONAL Industrial Power Unit Distributor can give you details on the whole IH line . . . can show you why INTERNATIONAL Power pays off for years to come.

INTERNATIONAL HARVESTER COMPANY
CHICAGO 1, ILLINOIS

INTERNATIONAL HARVESTER

INTERNATIONAL INDUSTRIAL POWER

MAKES EVERY LOAD A PAYLOAD



Technicians make final adjustments to VHF equipment used on BPC's Basrah telecommunications system.

Floods and windstorms can do little damage to automatic dialing and teleprinter facilities that comprise

Unique Radio Communications in Iraq

V. S. SWAMINATHAN

THE most vulnerable part of communications systems in Iraq are long telephone lines. Storm damage, vehicle accidents, humidity, and even birds' nests can put lines out of action; and these difficulties have been very serious at Basrah in Iraq. Much of the terrain is salt marsh, inundated for weeks at a time by flood water with resultant high humidity; sandstorms are frequent, and the region is subject to sudden fierce winds that are somewhat destructive.

A study of these practical difficulties, together with careful estimates of construction and maintenance costs, led to the recent commissioning of a multichannel VHF communications network with automatic dialing and teleprinter facilities at Basrah. It links the administrative and maintenance headquarters of the Basrah Petroleum Company with Zubair oilfields on the one hand and the tanker loading terminal at Fao on the other.

The system provides three fully automatic exchanges at Zubair, Makinah, and Fao, linked together by three direct and three indirect telephone channels with full inter-dialing facilities. The unit also has duplex teleprinter working between the main centers, together with through working magneto telephone and teleprinter circuits for oil pumping control between Zubair and Fao.

Special features of the installation comprise the full duplication of radio equipment with automatic changeover to standby transmitter and receiver bays in the event of failure of equipment, and an unattended VHF radio repeater station at Seeba with remote alarm indication at the Makinah headquarters to cover power generating or radio equipment faults. Standby diesel generators with automatic start features in the event of mains failure are provided at each station for emergencies.

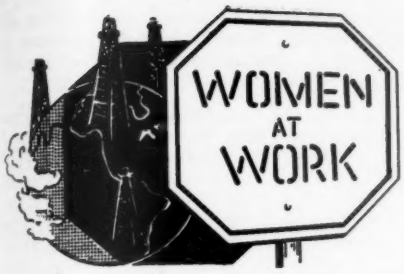
The unique feature of the new Basrah system is the application of fully automatic exchange principles over the VHF beams. A subscriber at Zubair, for instance, can dial up any number he wants at Zubair, Makinah, or Fao without the intervention of a telephone operator. A completely separate circuit for oil pumping control between Zubair and Fao uses the magneto telephone principle so that intrinsically safe apparatus can be used in hazardous areas at either end.

This circuit connects the Zubair No. 1 degassing station with the Fao oil control station; at both places small intrinsically safe switchboards extend lines out to tank farms and other hazardous localities. Teleprinters for general telegram traffic, are functioning between Zubair-Makinah and Makinah-Fao. A special teleprinter circuit between Zubair and Fao deals solely with oil figures and oil control messages.

Equipment for the system was supplied, and the job of installing the four stations at Zubair, Makinah, Seeba, and Fao, carried out by the Automatic Telephone and Electric Company, Ltd., and British Telecommunications Research, together with the British Petroleum Company staff, including a team of six young Iraqis, recruited from Basrah Secondary School. * *

EXCLUSIVE

XUM



Wynn Oil Company Executive

Cinderella has nothing on Beatrice P. Wynn. A shoe that fitted Cinderella brought her fame and fortune. A job that fits Beatrice brought her a top executive job with Wynn Oil Company.

The story began seven years ago when dark-haired, brown-eyed concert singer Beatrice Shelley moved to San Gabriel, California, to be near her ill mother. Bee had sung in New York and Hollywood (where her voice was used to dub-in singing for stars), but when she moved to San Gabriel she decided to enter the field of business. So she answered an ad for purchasing agent at Wynn Oil Company.

The mushrooming young business that produces a line of chemical products, which combined with oil reduces friction between moving metals, had been founded by Chestien Wynn in 1939 in a one-room garage. It was Chestien's son, Carl Wynn, who hired the young applicant and set her to finding scarce materials.

Bee Wynn lauds Wynn Oil.

"It was a little like being a detective," Bee remembers, "tracking down materials from clues picked up here and there."

Wartime restrictions had been holding back discoveries made by the company's founder, and Beatrice, in addition to purchasing duties, became administrator and promoter.

Today she is an administrative executive and a director of the multi-million-dollar company. In addition, she married President Carl E. Wynn.

The pretty executive and her husband have found that business and marriage mix like a charm.

"Wynn Oil Company is important to both of us," she says, "All day we work hard at it. In the evening we go home and get away from it. We try not to talk business at home," she smiles, "but we sometimes forget ourselves."

The Wynns live on an avocado and orange ranch not far from Azusa. Bee is a three-dimensional color photography enthusiast. She's working on a three-dimensional screen to show her exotic flower pictures more effectively. If she accomplishes this, she can add "inventor" to her already staggering list of accomplishments.

Deep Rock Office Manager Clark.

Twin Cities Representative

Although there is no such thing as an indispensable employee, some come close. One who does is Ellen Lee Clark, office manager of Deep Rock Oil Corporation in Minneapolis, Minnesota.

Ellen Lee Clark came with Deep Rock in 1931 after business training at Minneapolis Business College, and some training at the University of Minnesota. She has been with the company ever since, moving up from file clerk, to assistant in the credit department, to commission clerk, to clerk in the tax department, to supervisor of the company's sales service office, to office manager.

"This series of advancements testifies that we consider her services of the highest quality and feel fortunate in having such a capable girl with us," says A. M. Oleston, district manager.

Ellen Lee is an active member of the Twin Cities Desk and Derrick Club, was one of its charter members, and has held several offices. She gets almost as excited boosting the University of Minnesota Gophers as she does boosting Deep Rock products. She bowls, golfs, china paints, gardens—and when she retires plans to add a host of far-away places to her already extensive travels.

Betty Hunt helps run Suntide.

A Top Woman in Refinery

"I think refining is the most fascinating aspect of this intriguing business of oil," says Betty Hunt of Suntide Refining Company, Corpus Christi, Texas, and she knows what she's talking about. Betty was a part of the company when it was formed—"I'd been with Mr. F. L. Martin and Mr. T. C. Bodley all my working life, and when they formed Suntide it was just natural that I become a part of it." She has filled most positions in the company from bottom to top. "When a company is just beginning, you do about everything!" Betty was recently named assistant secretary of Suntide.

"I've watched this company grow from blueprint through actual construction. I've seen dreams fulfilled and plans become realities. I've watched that refinery go on stream and into actual operation. It's been a rare and wonderful privilege. Naturally, I'm prejudiced, but it seems to me that when you consider the various facets involved in processing crude petroleum into its multitude of finished products, you must agree with me that the refining end of the petroleum industry is the most exciting!"

A native Oklahoman, Betty went to high school and college in Tulsa. Her first job was with Mid-Continent Pipe Line Company where she was secretary to T. C. Bodley. When he transferred to Sunray Oil Corporation, Betty transferred too. She then became executive secretary to F. L. Martin, executive vice president of Sunray. In 1952 when Martin and Bodley went to Corpus Christi to form Suntide, Betty never entertained one doubt about going along.

Betty is very active in Corpus Christi Desk and Derrick Club, Beta Sigma Phi, and is an enthuiastic bowler.

PERSONALS

David A. McCaulay has been promoted to research associate at the Whiting, Indiana, research laboratories of Standard Oil Company of Indiana. He will serve in the hydrocarbon research division. McCaulay joined Standard in 1944 as a chemist after doing atomic energy research for the Manhattan project. He received bachelor's and master's degrees in chemistry at University of Chicago.

T. C. Waywell, assistant eastern divisional controller of Tide Water Associated Oil Company, has been appointed to the post of assistant treasurer. He began his service with the company in 1924 with the internal auditing staff and served as auditor until 1927, when he was appointed chief accountant. He acted as regional controller from 1936 to 1939 when he was appointed to the assistant controller's post.

The New York Lehigh Club honored **M. J. Rathbone,** president of Standard Oil Company of New Jersey by presenting him with its L-in-Life award in recognition of his services to the business world, to his community and to Lehigh University. Rathbone, a graduate of Lehigh and a member of its board of trustees, was chosen by the club's Board of Governors, representing some 3000 members in the New York area, which each year nominates a prominent graduate for the citation. Rathbone was elected president of Jersey Standard, effective January 1, 1954.

Oil and Gas Property Management, Inc. has announced the election of **C. C. (Mike) Harter, Jr.,** Dallas, Texas, executive vice president; **Lee J. Thronson,** Dallas, vice president, and **Harry Leyendecker** of Houston, Texas, vice president. **Glenn Eckel,** Amarillo, Texas, was elected a vice president of the Dorchester Corporation, which is owned by Oil and Gas Property Management.

Appointment of administrative and staff personnel of The Texas Company's research and technical department has been announced. **Dr. Wayne E. Kuhn** is general manager of the department; **W. A. McMillan,** assistant general manager; **Gus Kaufman,** manager (operations).

W. J. Coppoc is manager of research; **T. C. Heisig,** assistant manager of research (products); **C. E. Moser,** assistant manager of research (process).

Technical services division assignments include **R. W. Hall,** manager of technical services; **A. L. Brodie,** assistant manager of technical services (automotive); **M. L. Langworthy,** assistant manager of technical services (manufacturers' service); **R. R. Thurston,** assistant manager of technical services (industrial products). At Beacon, New York, laboratories, **C. E. Cummings** has been named superintendent; **R. L. Sawyer,** director of research; **R. E. Conary,** assistant director of research; **Bruce Hegeman,** director of technical services. At Port Arthur and Port Neches, (Texas) research laboratories are **C. T. Anne,** superintendent, and **H. D. Massin,** director of research. At Montebello, California, research laboratory, **du Bois Eastman** is director of research. The following have been named regional manager, technical services, in the territorial offices indicated: **B. Y. McCarty,** Chicago; **C. E. Emmons,** Los Angeles; **O. P. Puryear,** Houston. **K. L. Hollister** is technical representative for the department in Detroit.

Union Oil Company has anounced the election of **Elmer H. (Buck) Weaver** as a vice president. During the past year Weaver has been on loan to the United States Government as assistant director, Office of Defense Mobilization, in charge of critical materials and stockpiling. Prior to leaving for Washington he had been manager of Union's purchasing department for many years and upon his return was made director of procurement and contracts. Weaver started with Union Oil in 1918 as a buyer.

Appointment of **John S. Tate** as assistant treasurer of Standard Oil Company of California has been announced. Tate joined Standard in 1947 after obtaining a master's degree in business administration at Stanford University. He was graduated from Dartmouth in 1941 and served four years in the Navy.

The third Russell brother to retire after 50 years of continuous service, Percy C. Russell, right, of Bayonne, New Jersey, is presented an engraved wrist watch by Vice President H. A. Jackson, general manager of Tide Water Associated Oil Company's eastern division. Presentation was made in recognition of Russell's 50 years at Tide Water's Bayonne refinery. In the background, left to right, are Harry Russell, of Cliffwood, who had 55 years of service at the refinery; William Higgins, of the refinery employee relations staff; S. W. Candee, divisional supervisor of employee relations; Vice President H. S. Chase, divisional manager of manufacturing, eastern division, and Elliott Russell, of Cliffwood, who retired with 50 years of service.

Visitors at the New York Chapter of Nomads included: (left to right, standing) Michelle Tripier, The Texas Company, Dakar, Africa; George Knight, Eastern Gulf Oil Company, England; L. P. Hulin, Hayward Tyler and Company, England; S. J. Philippides, Chicago Pneumatic Tool Company, Lima, Peru; D. A. Ingalls, International General Electric S. A., Colombia; and L. E. Birdsong, Mene Grande Oil Company, Venezuela. Seated are Hugh Thompson, California-Texas Oil Company, California; Walter Koehler, Arabian American Oil Company, Lebanon; Jim Noel, Arabian American Oil Company, Saudi Arabia; Y. T. Gulez, Colombia Petroleum Company, Colombia; and Ian Goldie, Masons and Company, Trinidad, B. W. I.

The Los Angeles Chapter of Nomads meeting at the Jonathan Club honored international guests and speaker of the evening. Standing, left to right, are M. Hulshiza of Drilling and Exploration from Arabia; E. Arch Brown, formerly with Shell in Venezuela; A. C. Martin of Gulf Oil Corporation, Tunisia; Lee E. Courteau of Gulf Oil Corporation from Sicily; Jack Stovall of Drilling and Exploration from Dhofar; W. C. Lance of I.P.C. from Qatar; Patricio de Solar of Santa Fe Drilling Company from Chile; Harold D. Devenish of Trinidad Oilfield Service from Trinidad; (ceated) Gus J. Jure of Drilling and Exploration, Arabia; W. P. Ries of I.P.C., from Bahrein; Roy C. Zornes of I.P.C. from Iraq; Stan Hill, speaker; H. H. Mitchell of I.P.C. from Iraq; Thomas M. Webb of Texas Oil Company from Venezuela.

XUM

Arthur T. Proudfit, who began his career in the oil industry 35 years ago as a field worker, has been elected a director of Standard Oil Company of New Jersey. Formerly president of Creole Petroleum Corporation, Jersey affiliate in Venezuela, he resigned that position to take over his new duties in New York. Proudfit, who attended Oregon Agricultural College, joined Standard Oil Company of Argentina in 1936 as supervisor of producing fields in Argentina. He began in the oil business in 1919 as a tool dresser for Huasteca Petroleum Company, Tampico, Mexico.

Visitors at the Houston chapter of Nomads monthly meeting included: front row, left to right, Henry J. Estes, Basrah Petroleum Company, Ltd., Basrah, Iraq; J. A. Wirtenson, Cia. Shell, Maracaibo, Venezuela; F. Menez, S. V. Repal, Algiers; and John H. Murrell, DeGolyer and MacNaughton, Dallas, Texas. In the second row are J. M. Gray, McCullough Tool Company, Houston, Texas; J. E. Plemons, Shaffer Tool Works, Houma, Louisiana; Don H. Manson, Asiatic Petroleum Corporation, Houston; C. D. Richardson, Transcontinental Gas Pipe Line Company, Houston; and G. A. Metz, Mid-Continent Supply Company, Houston.

P. C. Spencer, president of Sinclair Oil Corporation, New York, was re-elected chairman of the board of directors, and **Frank M. Porter,** of Fain-Porter Drilling Company, Oklahoma City, Oklahoma, was re-elected president of the American Petroleum Institute at the 34th annual meeting. **B. Brewster Jennings,** president of Socony-Vacuum Oil Company, Inc., New York, was reelected treasurer; and **Lacey Walker,** of New York, was re-elected secretary. Three new vice presidents elected by the board of directors are **J. G. Jordan,** Shell Oil Company, New York, API vice president for marketing; **E. B. McConnell,** of Standard Oil Company of Ohio, Cleveland, API vice president for refining; **A. W. Thompson,** of A. W. Thompson, Inc., Houston, Texas, API vice president for production. **Charles S. Jones,** Richfield Oil Corporation, Los Angeles, California, was re-elected API vice president for transportation.

Le Roy H. Hines has joined the investment firm of J. Barth and Company, as a consultant on matters relating to the petroleum industry. Hines, an independent petroleum consultant, was formerly vice president of Northern Pacific Railway, in charge of oil development. Prior to that he had been with Standard Oil of California in the land department and assistant to the vice president.

A. M. Gee, former director and general counsel for The Ohio Oil Company, received the American Petroleum Institute's Certificate of Appreciation at the organization's 34th annual meeting. He was one of nine men honored by the division of transportation in recognition of service to the oil industry through participation in the work of the Institute. **Charles S. Jones,** API's vice president for transportation, made the presentation. Gee retired April 1 under The Ohio Oil Company's annuity plan following 34 years of service.

Bushrod B. Howard has retired from Standard Oil Company of New Jersey after 34 years with the organization, nine as a director. Howard, who graduated from the United States Naval Academy at Annapolis, joined Jersey Standard's marine operating division in 1920. In 1939, he was appointed general manager of the marine department, which is now the Esso Shipping Company. He was called to London in 1941 as a representative of the United States Maritime Commission to aid in expediting tanker cargoes in the heavily-bombed British ports. Also, at the request of the War Shipping Administration, he spent considerable time in West Africa, India, the Middle East, and the Suez area to devise methods for speeding up the movement of essential cargoes. In 1943 he was elected president of War Emergency Tankers, Inc., an agency formed by some of the major oil companies at the request of the government to provide adequately trained personnel and to operate the government's tanker fleet for the War Shipping Administration. He was awarded the President's Certificate of Merit in 1948 for "outstanding fidelity and meritorious conduct" during the war.

Creole Petroleum Corporation has announced the election of **H. W. Haight** as president, succeeding **A. T. Proudfit.** Haight has been executive vice president of Creole for the past four years. He will be succeeded by **H. A. Jarvis,** a director since 1952. Creole also announced the election of **L. E. Lowry,** now a director, to the executive committee, and the election to the board of directors of **H. J. Wright,** manager of the industrial relations department. Haight joined Creole in Venezuela in 1945 as production manager and was elected a vice president and director the following year.

Scott B. McCabe has been appointed division accountant for the Texas-Louisiana division of Stanolind Oil and Gas Company. He succeeded **D. M. Withers,** who is now division office manager for Stanolind's Canadian operations at Calgary.

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THREADING ½" to 4" PIPE
Bring down Costs!

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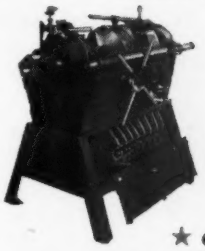
POWER PIPE MACHINE
makes the job Easier!



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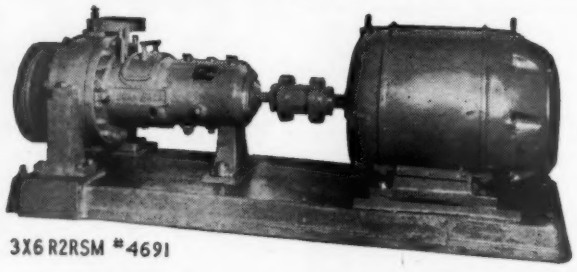
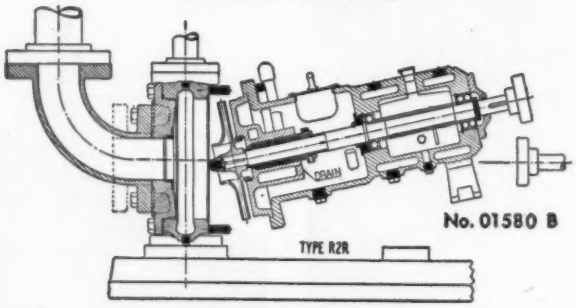
Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

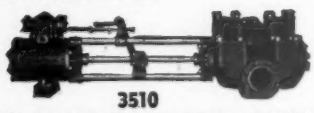
DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R, Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

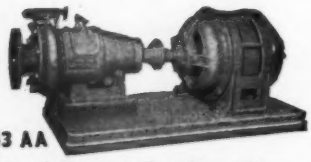
BUILDERS OF OUTSTANDING PUMPS SINCE 1869

CENTRIFUGAL AND RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

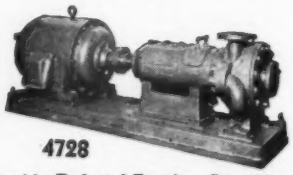


3510
Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

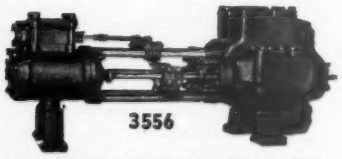


4043 AA
Pedestal Mounted Centrifugal Pump

3833
Horizontal, Duplex, Double Acting Side Pot, Piston Type, Oil Bath Power Pump



4728
Double Pedestal Bearing Centrifugal Pump



3556
Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

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Representatives in Principal Cities

Personals

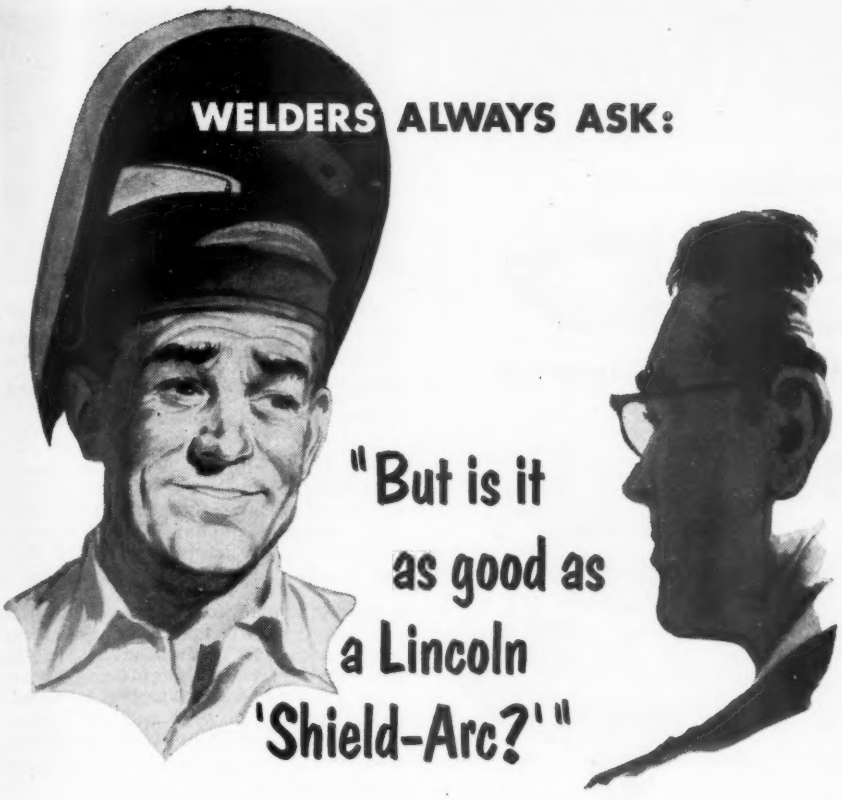
W. C. McCammon

▸ Appointment of **W. C. McCammon** to the newly-created post of assistant to the president of Standard Oil Company of California has been announced. McCammon, who has served as assistant comptroller of the company since 1944, joined Standard in 1932 and has spent his entire business career with the company. He was graduated from the University of California in 1930 and took a year's graduate study at the Harvard School of Business Administration.

▸ **Douglas McKay,** Secretary of the Interior, has appointed **Hugh A. Stewart** as director and **Carroll D. Fentress** as assistant director of the Oil and Gas Division. Stewart has been acting director since the division was reestablished following termination of the Petroleum Administration for Defense. A geologist with 25 years experience with The Texas Company, he was director of the original Oil and Gas Division from November 1949 to October 1950. Fentress has been with the Division since 1946 except for a 3-year period with PAD. His military service included a detail to the Petroleum Administration for War from February 1944 to August 1945. He was employed by Standard Oil of Indiana before entering military service.

Thomas H. Miller has been named deputy director of the Bureau of Mines. Miller has been with the bureau for more than 26 years, the last 8 as assistant director. **Harold M. Smith** will be director of the region comprising Texas, Oklahoma, Missouri, Mississippi, Louisiana, Kansas, and Arkansas. **Clifford W. Seibel,** formerly a regional director, has been selected as assistant bureau director in charge of helium operations.

▸ The Oil Industry Information Committee of the American Petroleum Institute has announced the appointment of **William R. Mizelle** as editorial director. Mizelle will supervise the preparation of editorial material for publication by the Oil Industry Information Committee. Until joining the OIIC, Mizelle was project manager of the McGraw-Hill Book Company's technical writing service, having served the McGraw-Hill organization in various capacities since 1949. Previously, he was associated successively with the Birmingham News-Age Herald, United Press, and the New York Times. He was educated at Birmingham-Southern College, the University of Alabama, and New York University.



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1. "Shield-Arc" delivers *any* type of direct current arc . . . not one or two types.

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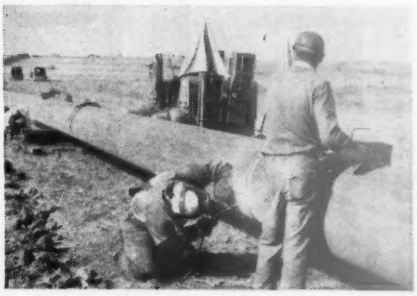
3. "Shield-Arc" welders are constantly improved to weld faster...at lower and lower costs.

LINCOLN "SHIELD-ARC" SA-200 DC ENGINE-DRIVEN WELDER

"Shield-Arc" is built in 200, 300, 400, 600 amp sizes, portable or stationary.



ON PIPELINES

Fig. 1. Completes final pass on 24-inch Rancho Pipeline with "Shield-Arc" SA-200 welder and Lincoln "Fleetweld 5" electrode. Welds are solid, uniform, free of pin holes.

ON FABRICATION

Fig. 2. 8" pipe spool is fabricated at low cost in field shop set up next to refinery using ells and flanges butt welded with Lincoln "Shield-Arc 85" and "Fleetweld 5" electrodes.

ON CONSTRUCTION

Fig. 3. Rigid frame for compressor station is fabricated from standard "I" beams. Members are shop fabricated with fast downhand techniques. Field erection takes 5 days.

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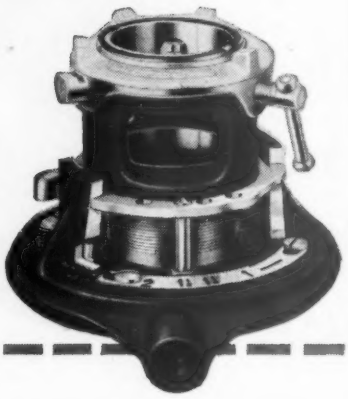
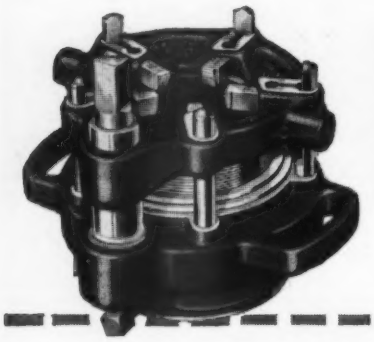
RIDGID 65R

Threads 1" to 2" pipe with 1 set of dies —and it won't jam. Sets to pipe size in 10 seconds! Workholder sets to size instantly. 65R's great popularity has been earned on thousands of tough jobs.





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RIDGID 00R

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RIDGID

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Personals

Jerry Stumm, *The Petroleum Engineer* staff, and Vince Teague, Fluor Corporation, right, attending session of the California Natural Gasoline Association at Los Angeles.

▸ **E. Allan Morrow** has been named president of Roosevelt Oil and Refining Corporation, succeeding John E. Boudler, who resigned. **Stanley Martin** was appointed vice president and **Frank M. Horgan** was named secretary and treasurer.

▸ **Harold B. Fell,** executive vice president of the Independent Petroleum Association of America, has announced that he will tire February 1 after more than 25 years with IPAA. He presided at IPAA's organization meeting in 1929 and has been an officer ever since. He is president of Simpson-Fell Oil Company and Rickey Royalty Corporation.

▸ **Brewster C. Stoner,** supervisor of production and pipe line accounting for Deep Rock Oil Corporation for 27 years, has resigned to accept a position with Sinclair. He will have headquarters in Venezuela.

▸ **H. W. Brown,** Tulsa, Oklahoma, who began his oil industry career 26 years ago as a seismograph operator, has been elected a director of The Carter Oil Company. He succeeded **Nelson Y. Ruth.** Brown has been manager of the Carter exploration department since September 1, 1953. **Merrill W. Haas,** chief geologist for Carter since 1951, succeeds Brown as exploration manager.

▸ **J. Howard White** has been appointed financial vice president of Shell Oil Company. White had been vice president and controller since 1949. **A. A. Buzzi,** formerly assistant controller, was named to succeed White as controller. White joined Shell as a clerk in the treasurer's department in 1925. A graduate of the University of Southern California, he advanced through financial positions of increasing importance in the firm's West Coast area, becoming auditing department manager in 1937 and assistant treasurer in 1940. He was named vice president in 1944. Buzzi joined the firm at its Arkansas City refinery in 1923. He was transferred to New York as assistant manager of the auditing department in 1941, named assistant treasurer in 1948, and assistant controller in 1949.

▸ **John W. Gendron** has been appointed manager of the oil purchase and exchange department, Tide Water Associated Oil Company, a newly created position, according to announcement released by President **D. T. Staples.** Gendron will be responsible for regulating the supply and coordinating the crude and products requirements of the manufacturing and marketing operations of the Company. He entered Tide Water's service as a stock dispatcher in its western transportation department in 1946. He will make his headquarters in San Francisco.

XUM

Deaths

Ray E. Miller, advisor to the petroleum chemicals division of the organic chemicals department, Du Pont Company, died in Doctors Hospital, New York. He had resigned the post of the division's sales manager last year because of poor health. Miller was previously associated in executive capacity duties with Marland Oil (now Continental), Natural Gasoline Association of America, Hanlon-Buchanan Inc., and Warren Petroleum Corporation. He was a member of the board of directors of the American Petroleum Institute.

O. Oppenheimer, chairman and managing director of Challenge Oils Ltd. died recently. He founded the firm in 1896 and it moved to its present address in Howard Road, Stoke Newington, in 1900. Oppenheimer was active at his office until a few weeks prior to his death.

Thomas C. McCobb, former director of Standard of New Jersey, died at his home in Southport, Connecticut. He was director of Standard from 1934 to 1944 when he retired.

Henry B. Earhart, a director of the American Petroleum Institute, died recently at Ann Arbor, Michigan. He founded the Earhart Foundation and was a director of several oil companies.

Jackson R. Schonberg, staff engineer in the engineering department of Standard Oil Development Company, died in Westfield, New Jersey.

Henry L. Hathaway, sales manager for Standard Oil of Texas since 1940, died recently. He was formerly district manager at Bakersfield for Standard of California. He had also been associated with the company at San Francisco, Sacramento, San Jose and Tulare.

Joseph D. Grant, an employee of Carter Oil Company since 1918, died November 12 following a four-month illness. He was supervisor of the part interest section in the accounting department.

Dana H. Kelsey, former vice president of Sinclair Oil and Gas Company, died after a lengthy illness. He was associated with Prairie Oil and Gas Company and the Sinclair companies for 33 years before retiring in 1948.

John C. Day, secretary-treasurer of Western Petroleum Refiners Association, Tulsa, died recently. He had been with the Association since 1936. He was formerly associated with Wilcox Gas and Oil, Waite Phillips Company, and Barnsdall Refining.

Beatrice Woods Davidson, office manager of Leo Sanders Construction and Machinery Company, Oklahoma City, Oklahoma, died unexpectedly November 5 when making a talk. She had been with the company 18 years. A graduate of Oklahoma College for Women, she attended the University of Oklahoma and University of Colorado, where she received a master's degree. One of the founders of the oil women's association in Oklahoma which became the Desk and Derrick Club, "Bea" took an active part in it and other organizations. She was editor of the Desk and Derrick cook book and was the Oklahoma City nominee for the Woman of Achievement award.

Three Plymouth Oil Company employees were killed when their plane crashed in the Blue Ridge mountains near Waynesboro, Virginia, November 27. Dead were **W. M. Griffith,** vice president; **A. L. Laskamp,** chief geologist; and **Dan Graham,** regional geologist. Pilot and co-pilot of the plane were also killed.

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LAUGH with BARNEY

The collectors were pressing down on Rastus during a drive for church funds. "I can't give nothin'," pleaded the old Negro. "I owes nearly everbody already," "But," said one of the collectors, "don't you think you owe the Lord somethin', too?"

"I does, indeed," said the old man, "but He ain't pushin' me like my other creditors is."

A woman had been bitten by a dog, and was told by her doctor: "It's possible you may be carried off by hydrophobia, madam. So it may be well to note down your last wishes."

The woman busied herself with pen and paper for a long time. Finally the doctor said, "That's a long will, isn't it?"

"Will nothing, his patient snapped. "I'm just making a list of the people I'm going to bite."

The attorney was examining a witness in court.

"Have you ever been arrested before?"

"No, sir!"

"Are you sure of that?"

"Yes, sir!"

"Your face looks familiar. Where have I seen you?"

"Well, sir, I'm the bartender across the street."

Two inmates of the asylum were talking together.

"I've made up my mind," blurted one suddenly, with a fixed look of decision on his face. "Tomorrow I order my legions to invade England. History will never say that Julius Caesar faltered in pursuing the Britannic campaigns."

"England, eh?" mused the other thoughtfully. "Well, Julius, If I were you . . . and, incidentally, I am . . ."

An inebriate staggered into a bar and placed a big live lobster in front of him.

After downing a martini, he said, "Shay, you make the best martinis in town and I'm going to give you Ethelbert, my pet lobster."

"Fine," says the bartender, "I'll take him home for dinner."

"No, no, don't do that! He's had dinner. Take him to a show."

"Let's see your bait?" asked the native as the discouraged angler was about to give up.

The angler showed his minnows. The native fastened one by the tail to the angler's hook, pulled a bottle of corn liquor from his pocket, poured it into the minow bucket, "dunked" the minnow in it for a moment, and said, "Now try it."

Almost immediately there was a heavy strike and after a brief struggle a 15-pound bass was landed. Not on the hook, of course—the minnow had the bass by the throat.

Although most girls' bathing suits aren't as big as a postage stamp, they still deliver the males!

A traveling salesman, holed up in a small Kansas town by a bad snow storm, wired his firm: "Stranded here due to storm. Wire instructions."

This reply came back: "Start summer vacation immediately."

A none-too-modest hunter, on a hunting trip, took aim and fired, but the bird sailed on undisturbed. The marksman watched it in dazed silence then dashed his gun on the ground and shouted, "Fly on, you blankety-blank fool bird! Fly on with your gol-durned heart shot out."

Diner—I can't eat this egg you brought me.

Waiter—Isn't it cooked long enough?

Diner—Yes, but not soon enough.

Engineers are baffled by the fact that often the girls with the most streamlined shapes offer the most resistance.

"Morning, Mandy Lee."
"Morning, Deacon."
"Your mama home?"
"Yeah, Deacon, she's home."
"Your papa home?"
"Yeah, Deacon, he's home."
"Well, Mandy Lee, just say howdy."

A soldier was being inducted into the Army and with his physical over, the sergeant asked, "Did you go to grammar school?"

"Yes, sir, I also went through high school, graduated cum laude from college, completed three years of graduate studies and then received two more degrees."

The sergeant nodded, reached for a rubber stamp and slapped it on the questionnaire. It consisted of a single word: "Literate."

Then comes the one about the certain engineer who returned home one night at a late hour and, finding difficulty with his equilibrium, made considerable noise in the hallway. Suddenly there was sound of crashing glass which awakened his wife.

"Bill," she called, "what's the matter?"

From downstairs came a low mumble, "I'll teach those goldfish to snap at me."

"Why did you strike this man?" the judge asked the prisoner up before him for assault and battery.

"It was this way, your honor," answered Pat. "He told me he was Irish by descent and I couldn't stand there and let any man say he had to come down to be Irish."

The day "Big Jim"—a two-fisted oil driller—took a trip to see his prize well, a wire was waiting for him at the site—he was to return at once to the hospital where his wife was a patient.

Back home, Jim located the doctor and demanded: "What's the matter with the little woman, Doc?"

"Everything's going to be all right," the specialist assured him. "We just wanted your consent to perform an exploratory operation."

Jim's answer was immediate and final: "No, you don't! Ain't nobody going to wildcat on my wife!"

Sales Manager: "For heaven's sake, what's this enormous item on your expense account?"

Salesman: "That? Why it's my hotel bill."

Sales Manager: "Well, quit going around buying hotels!"

The mind is a wonderful thing. It starts working the minute you're born and never stops until you stand up to speak in public.

Walking into the post office, a man listened to two girls talking behind the counter. "She wore a divine cloak: it was a redingote design in gorgeous brocade, trimmed with fox fur and had wide pagoda sleeves. It must have cost $50 if it cost a nickel."

At this point the impatient gentleman interrupted. "Excuse me, I wonder if you could provide me with a dinky little stamp with perforated hem, treated on the reverse side with a light coating of gum arabic? Something for about two cents?"

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BOOKS ★

The Use of Stereographic Projection in Structural Geology, *by F. C. Phillips. Published by Edward Arnold, Ltd., London, England. Pages, 85. Price, $3.00.*

The device of stereographic projection is an ancient one, being used in Greece in the second century B.C. It has won great popularity in the hands of crystallographers, who developed it for the study of crystal morphology and crystal optics. The principle has now come to be of great use in the solving of problems that arise in the study of structural geology.

The most generally used methods in solving problems involve the application either of descriptive geometry or of trigonometry and also the use of "three-dimensional" figures. The use of stereographic projection is said to afford the neatest representation of three-dimensional geometry and to combine ease of solution with extreme speed.

The author states that the book was designed for the working structural geologist with no previous knowledge of the principle of the stereographic projection and it is intended to be brief and simple. In this the author succeeded, but not to the detriment of the subject. He makes ample use of illustrations and diagrams in demonstrating applications of the stereographic projection method for the various problems posed in each of the book's seven chapters.

Fisher/Tag Manual, *published by Fisher Scientific Company, 717 Forbes Street, Pittsburgh, Pennsylvania. Price, $1.75. Pages, 220.*

The 1954 Fisher/Tag Manual is a new book from cover to cover, with larger pages so that text and tables are more legible (yet is still pocket-size). The book is bound in dark blue. It gives all the essential details for 35 of the most widely used tests for basic physical and chemical properties of petroleum and its products, such as gravity, color, viscosity, distillation range, vapor pressure, gum content, sulfur, carbon residue, flash point. water and sediment, melting point, cloud and pour points, consistency.

The most useful of the conversion tables adopted internationally in 1953 are reprinted in full in the Manual; others are abridged. Twenty-one other tables have been added. The book has a complete cross-index and a separate numerical index to the official ASTM methods used in the book.

Statistical Analysis, *published by John Wiley and Sons, New York and London. Pages, 724. Price, $8.00*

Statistical Analysis in Chemistry and the Chemical Industry is sponsored by the Committee on Applied Mathematical Statistics of the National Research Council and goes into the subject as extensively as a single, 724-page volume can cover it. After introductory Chapter 1, which discusses the nature of these methods and some problems to which statistical methods may be applied, it attacks the subjects of descriptive statistics, the mathematical machinery, relationships between variables, analysis of variance, design of experimental analysis of data, control charts, tests for randomness. All these subjects are aided in the volume of extensive appendices, and the book is expected to be both a reference work and a text book to the student of statistics and those who practice in this field.

The Oil Business As I Saw It, *W. L. Connelly, University of Oklahoma Press, Norman, Oklahoma. Pages, 177. Price, $3.75.*

If W. L. Connelly's life had a dull moment, there is no space for it in "The Oil Business As I Saw It." It is a swinging bouyant march through 60 years of goings on the oil industry by Connelly, who went from roustabout to chairman of the board of Sinclair Oil and Gas Company. The story is told authentically and amusingly.

Connelly's career has been associated with the oil industry in many areas—Pennsylvania, Ohio, Kansas, Oklahoma, Texas, Wyoming, Mexico, Venezuela, Angola in Southwest Africa, Germany, and Austria. It was in Kansas that he met and became associated with Harry F. Sinclair. Under his observant eyes boom towns have been born, some to decline and others—like Tulsa, Houston, Dallas, Fort Worth, Shreveport, and Oklahoma City—to rise to industrial greatness.

Wherever we follow the author in the exciting pages of this book we are able to see the world as it was before oil, the motor car, and modern highways had transformed its slow existence to the tempo we now know.

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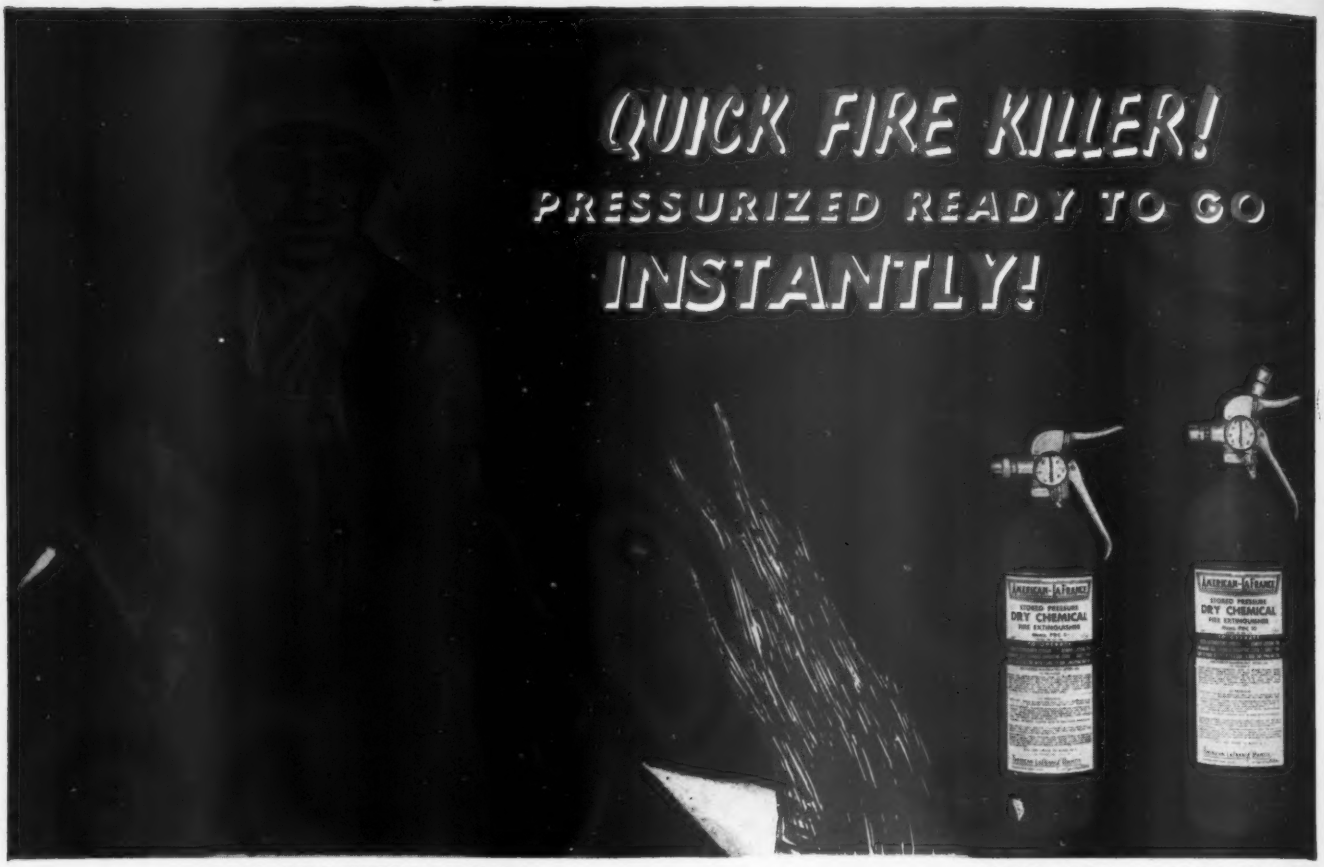

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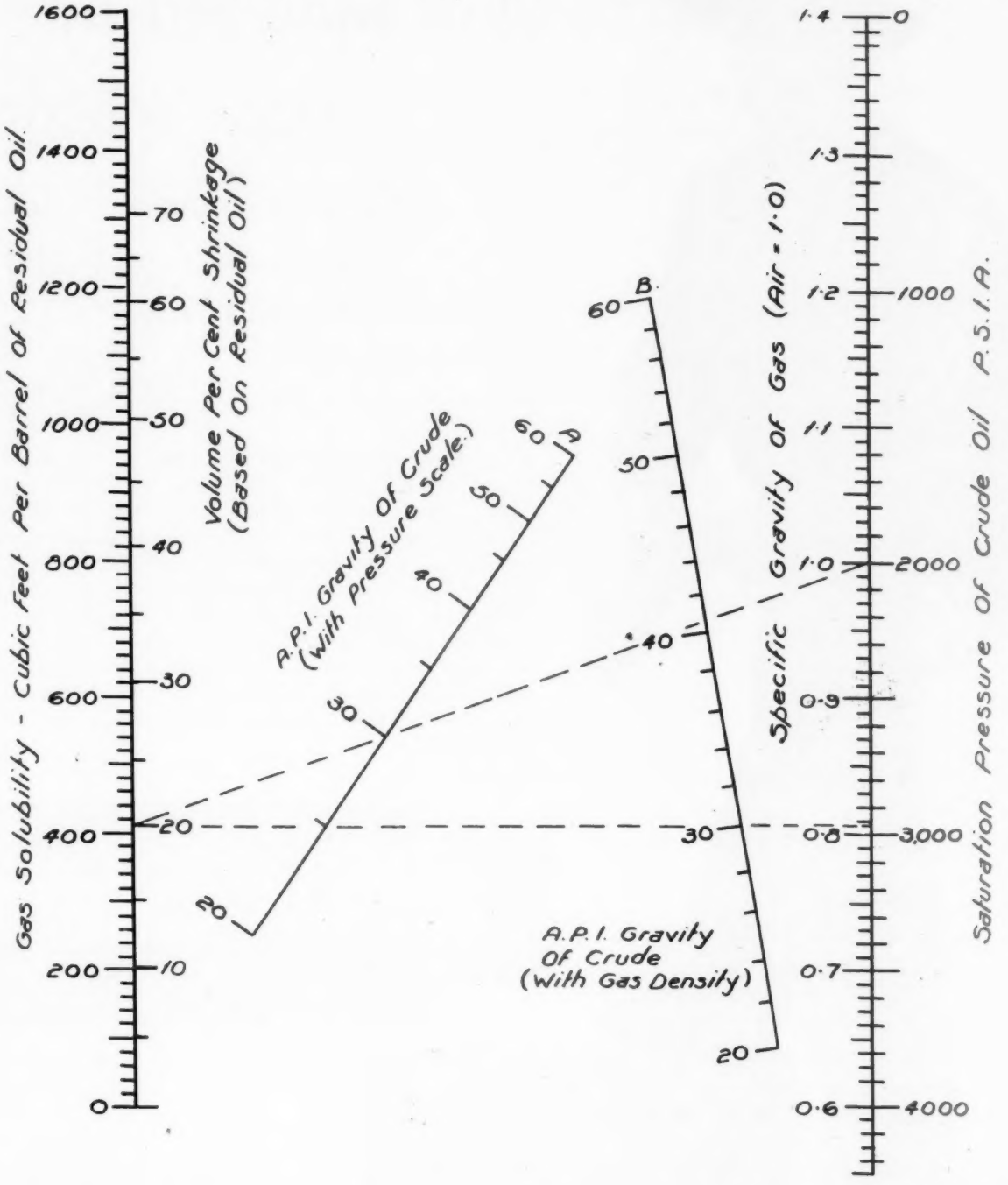
CHART FOR ESTIMATING CRUDE OIL SHRINKAGE



Katz[1] has presented data correlating the loss of oil volume due to the release of dissolved gases with the saturation pressure of the oil and its gravity. This data is presented here in a convenient nomographic form together with the further relationship he derived between the gas solubility, oil gravity and gas density. The value and application of the chart are best illustrated by means of a worked example.

Example: A 30 deg API crude has a formation saturation pressure of 2000 psia.

1. What is the gas solubility and the volume per cent shrinkage on stabilization? Connect 2000 psia on the right hand scale with 30 deg API on the A gravity scale and extend the tie line to the left hand scale to give the gas solubility as 410 cu ft per barrel and the oil shrinkage as 20 per cent.

2. What will be the specific gravity of the released gas? Connect the gas solubility on the left hand scale with 30 deg API on the B gravity scale and extend the tie line to give the gas specific gravity of 0.807.

Reference

1. Katz, D. L., *Oil Weekly*, November 30, 1942, pp. 17-32.

Contributed by George E. Mapstone, Transvaal, South Africa.

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Allowable Internal Working Pressures
For 3S-H14 and Alclad 3S-H14 Tubes

The values for internal pressures given below were calculated in accordance with the following formula:

$$P = \frac{0.95S}{4} \cdot \frac{(d^2_1 - d^2_2)}{d^2_1 + d^2_2}$$

in which P = allowable internal working pressure, psi.,
S = 19,500 psi., which is the minimum longitudinal tensile strength of 3S-H14 and Alclad 3S-H14 tubing,
d_1 = nominal outside diameter, inches,
d_2 = nominal inside diameter, inches.
The factor 0.95 is used to take care of factors such as the difference between longitudinal and circumferential tensile strengths.

Nominal Outside Diameter, Inches	SPECIFIED WALL THICKNESS Inch	Stubs' Gage No.	ALLOWABLE WORKING PRESSURE, PSI., For Metal Temperatures Not Over 100 °F or Less	200 °F	300 °F	400 °F	500 °F
⅝	0.049	18	780	720	625	500	350
	0.058	17	940	865	750	600	420
	0.065	16	1060	975	850	680	475
	0.072	15	1185	1090	950	760	535
	0.083	14	1385	1275	1110	885	625
¾	0.049	18	645	590	515	410	290
	0.058	17	770	710	615	495	345
	0.065	16	870	800	695	555	390
	0.072	15	975	895	780	625	440
	0.083	14	1135	1045	910	725	510
	0.095	13	1315	1210	1055	840	590
	0.109	12	1530	1410	1225	980	690
⅞	0.049	18	550	505	440	350	245
	0.058	17	655	600	525	420	295
	0.065	16	740	680	590	475	335
	0.072	15	825	760	660	525	370
	0.083	14	960	885	770	615	430
	0.095	13	1110	1025	890	710	500
	0.109	12	1290	1190	1035	825	580
1	0.049	18	475	440	380	305	215
	0.058	17	570	525	455	365	255
	0.065	16	640	590	515	410	290
	0.072	15	715	655	570	455	320
	0.083	14	830	765	665	530	375
	0.095	13	960	885	770	615	435
	0.109	12	1115	1030	895	715	505
	0.120	11	1240	1140	990	795	560
	0.134	10	1400	1290	1120	895	630
1⅛	0.049	18	420	385	335	270	190
	0.058	17	500	460	400	320	225
	0.065	16	565	520	455	360	255
	0.072	15	630	580	505	405	285
	0.083	14	735	675	585	470	330
	0.095	13	845	780	680	540	380
	0.109	12	985	905	785	630	440
	0.120	11	1090	1005	875	700	490
	0.134	10	1230	1130	985	785	555
1¼	0.049	18	375	345	300	240	170
	0.058	17	450	415	360	290	205
	0.065	16	505	465	405	325	230
	0.072	15	565	520	450	360	255
	0.083	14	655	605	525	420	295
	0.095	13	755	695	605	485	340
	0.109	12	875	805	700	560	395
	0.120	11	975	895	780	625	440
	0.134	10	1095	1010	875	700	495
1⅜	0.049	18	340	315	275	220	155
	0.058	17	405	375	325	260	185
	0.065	16	460	420	365	295	205
	0.072	15	510	470	410	325	230
	0.083	14	595	545	475	380	265
	0.095	13	685	630	545	440	310
	0.109	12	790	730	635	505	355
	0.120	11	880	810	700	560	395
	0.134	10	990	910	790	635	445
1½	0.049	18	315	290	250	200	140
	0.058	17	370	340	300	240	165
	0.065	16	420	385	335	270	190
	0.072	15	465	430	375	300	210
	0.083	14	540	500	435	345	245
	0.095	13	625	575	500	400	280
	0.109	12	720	665	580	460	325
	0.120	11	800	735	640	510	360
	0.134	10	900	830	720	575	405
1¾	0.049	18	265	245	215	170	120
	0.058	17	315	290	255	205	145
	0.065	16	355	330	285	230	160
	0.072	15	395	365	320	255	180
	0.083	14	460	425	370	295	205
	0.095	13	530	490	425	340	240
	0.109	12	615	565	490	390	275
	0.120	11	680	625	540	435	305
	0.134	10	765	700	610	490	345
2	0.049	18	235	215	185	150	105
	0.058	17	275	255	220	175	125
	0.065	16	310	285	250	200	140
	0.072	15	345	320	275	220	155
	0.083	14	400	370	320	255	180
	0.095	13	460	425	370	295	205
	0.109	12	530	490	425	340	240
	0.120	11	590	540	470	375	265
	0.134	10	660	610	530	425	300

These computed allowable pressures are based on the nominal dimensions of the tube itself, with no allowance for efficiency of joints.

All figures are based on a factor of safety of 4.

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Now Cutler-Hammer offers an

IMPROVED OIL WELL PUMPING CONTROL

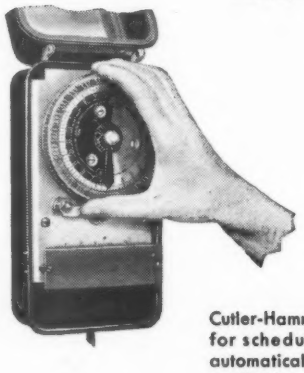
. . . that provides easy in-the-field modification of restarting characteristics

The NEW Cutler-Hammer Oil Well Pumping Control offers the same features which have made it the outstanding choice of oil field engineers; famous C-H dust-safe vertical contacts, finest program time-switch, *full* three-phase overload protection, incomparably cool C-H trouble-free operation. But another *exclusive* advantage has been added. This control may now be modified easily *while in use* to meet changes which occur in field operating conditions. The control panel now readily accepts either a C-H Low-Voltage Relay or a C-H Time-Delay Relay; panel space is provided and the panel is drilled. A diagram inside the cover shows all circuit arrangements with leads numbered to permit easy wiring changes.

Every oil field engineer will quickly grasp the significance of this improvement. With the basic Cutler-Hammer Oil Well Pumping Control, pumps resume operation as soon as power is restored after an interruption . . . as when lightning strikes the power lines. This is fine when there are only a few wells. But as a field grows, the combined load of many pumps restarting together is too heavy. Then either C-H Low-Voltage or Time-Delay Relays are added to the control. Low-voltage relays drop open on power interruptions and must be reset at each well. Pumps are thus restarted one at a time. Where automatic restarting is desired, the time-delay relays are used . . . set for different time intervals. When power is restored after an outage, one pump after another then restarts automatically . . . as determined by the different time-delay settings.

Ask to see this new control now. Or write for descriptive bulletin. CUTLER-HAMMER, Inc., 1459 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

Improved C-H Oil Well Pumping Control permits easy in-the-field modification to the type of restarting desired after power interruptions.



Cutler-Hammer Program Time Switch for scheduling of pumping cycle automatically. Day-omission feature available.

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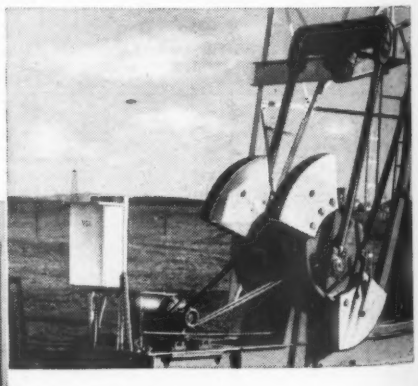
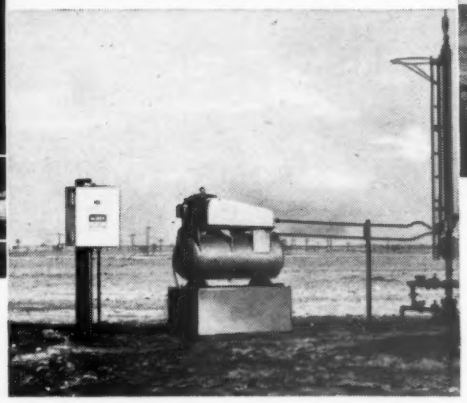
CUTLER-HAMMER
MOTOR CONTROL
C-H

Midland County, Texas

Hot Springs County, Wyoming

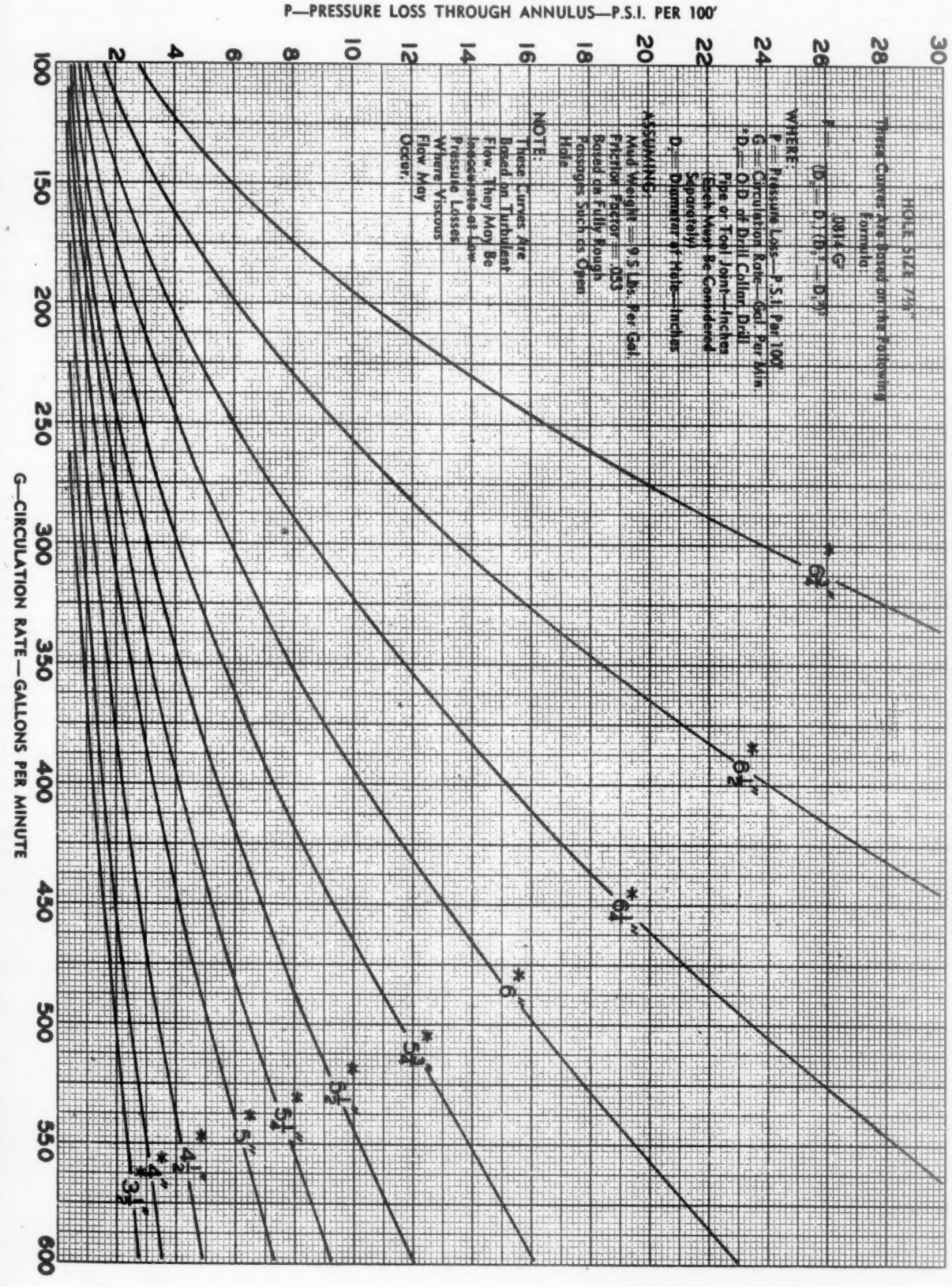




Lea County, New Mexico

XUM

DRILLING HYDRAULICS


P—PRESSURE LOSS THROUGH ANNULUS—P.S.I. PER 100'
G—CIRCULATION RATE—GALLONS PER MINUTE
FRICTION LOSSES DUE TO FLUID RETURN THROUGH THE ANNULUS
HOLE SIZE 7½"
These Curves Are Based on the Following formula:
WHERE:
P = Pressure Loss—P.S.I. Per 100'
G = Circulation Rate—Gal. Per Min.
D = O.D. of Drill Collar, Drill Pipe or Tool Joint—Inches (Each Must Be Considered Separately)
D₂ = Diameter of Hole—Inches
ASSUMING:
Mud Weight = 9.5 Lbs. Per Gal.
Friction Factor = .053
Based on Fully Rough Passages Such as Open Hole
NOTE:
These Curves Are Based on Turbulent Flow. They May Be Inaccurate at Low Pressure Losses Where Viscous Flow May Occur.
6¼"
6½"
6¾"
6"
5¾"
5½"
5¼"
5"
4½"
4¼"
3½"

Courtesy of Hughes Tool Company

OIL and GAS TRADE NEWS

Engineering Company Formed

Tuloma Builders, Inc., has been formed to handle engineering and construction of oil and gas facilities. Projects the new firm will handle include engineering and construction of gasoline plants, industrial plants, gas-compressor stations, oil pump stations, and water flood units. Top personnel of Tuloma formerly were with Midwestern Constructors, Inc., Tulsa, Oklahoma, engineering and construction firm.

G. E. To Build Gas Turbine

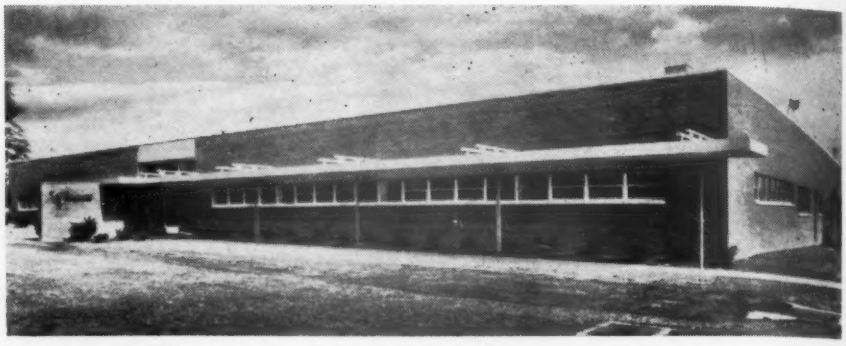
The largest gas turbine ever used to drive a merchant ship will be built by the General Electric Company for the U. S. Maritime Administration. The power plant is believed to be the first gas turbine application for a large merchant ship in this country. Unit is to be delivered during the summer of 1955.

Complete Chemical Laboratory

A new $150,000 dust-proof and air-conditioned control laboratory has been completed and put into operation at American Potash and Chemical Corporation's main plant at Trona, California. The two-story structure, measuring 60 ft long and 40 ft wide, is an all-metal windowless building constructed by Stearns-Roger Manufacturing Company. Incorporated in the equipment are the latest safety and convenience devices for use in the testing of chemicals.

Select Sales Representatives

Hanna Engineering Works has announced the appointment of two Southern firms as sales representatives covering North Carolina, South Carolina, and Georgia. The Barker Instrument and Machine Company has been selected to serve both of the Carolinas. Exclusive representatives for Hanna's entire line of air and hydraulic cylinders and valves for Georgia is the Carl B. Pederson Company.



France Packing Company's plant at Philadelphia, Pennsylvania, is part of an expansion program designed to meet increased needs for specialized equipment.

New Process Offered

Formation of the Armoloy Company, which will offer to industry an exclusive new process for armoring moving metal surfaces to provide longer wear, has been announced. The new Armoloy process, developed recently by Armoloy engineers, has been described as a "major advancement in industry's perpetual efforts to reduce friction on cutting surfaces."

Gar Wood Opens Branches

Two new direct factory truck equipment sales branches, in Tulsa, Oklahoma, and Springfield, Illinois, have been opened by Gar Wood Industries. Both branches will distribute the complete line of Gar Wood truck equipment, including Load-Packer refuse collection bodies, hydraulic hoists, and dump bodies, winches, and cranes. Branches will be managed by D. C. Royce, in Tulsa, and Carroll Merriett, in Springfield.

Gar Wood also announced the manufacture of the three-quarter millionth Gar Wood truck winch. Winch was part of recent government orders totaling approximately 2000 units.

Builders-Pacific Changes Name

B-I-F Industries, Inc., has announced that its West Coast affiliate, Builders-Pacific, Inc., has changed its name to B-I-F Pacific, Inc., West Coast Division of B-I-F Industries, Inc. Change was made to more closely identify this division with its parent company. It continues as the sales and service representative of Builders-Providence, Inc., Omega Machine Company, and Proportioneers, Inc.

Formation of a new Texas division with sales and service offices in Houston and Dallas, was also announced. It is known as B-I-F Texas, Inc., Southwest Division of B-I-F Industries, Inc. Move was made to provide increased accommodation and service to customers in the Southwest.

Republic Is Distributor

The Republic Supply Company of California, has announced that the firm has assumed the exclusive distributorship in California for the pumping unit line of the American Manufacturing Company of Texas. Republic Supply is carrying a complete line of American Manufacturing Company pumping units.

Fred Murray, president of Oil Well Supply division, U. S. Steel, breaks ground for an enlarged plant at Garland, Texas.

Otis Pressure Control, Inc.'s 4000-sq-ft warehouse and office building in Corpus Christi, Texas, has been opened. This is part of general expansion plans in South, East, and West Texas and at home office in Dallas, Texas.

McCullough Opens Office

McCullough Tool Company has opened a new sales office at 1236 Yost Street, Denver, Colorado. The office, in charge of J. M. Edwards, geologist and sales engineer, will serve the oil industry in the Denver area. Edwards joined McCullough Tool Company in April, 1953. Prior to that he had been associated with the Union Oil Company as a geologist. He is a graduate of the University of Southern California.

Kennametal Develops Turbine

A revolutionary experimental gas turbine which could lay the groundwork for increasing power of jet engines 50 per cent has been developed by Kennametal Inc. Using its super high-temperature alloy, Kentanium, in critical parts of the turbine, Kennametal operated it continuously for 100 hours at a temperature of 1850 to 1900 deg F and speed of 30,000 rpm. The new-type gas turbine is seen as having application, not only in the engines of jet planes but also in trucks, portable power plants, and in other equipment driven by turbines.

New Mill Depot Opened

A bonded mill depot has been opened by Wolverine Tube, Division of Calumet and Hecla, Inc. in the Rochester, New York area. Depot will stock Wolverine seamless nonferrous copper water tube, automotive tube, and refrigeration tube and is expected to increase speed of shipments to Wolverine Tube customers in central and western New York state. G. H. Tobelman, eastern district sales manager, will coordinate the new mill depot operations through Wolverine's Rochester office.

Representative Named

De Laval Steam Turbine Company of Trenton, New Jersey, has announced the appointment of Gumersindo Garcia, S.A. as its exclusive representative for Spain, Spanish Morocco, Tangiers, the Balearic, and Canary Islands. They will handle De Laval multistage centrifugal pumps, steam turbines, worm gears, and couplings.

Fittings Flown to Venezuela

Special pipe fittings made by the Ladish Company of Cudahy, Wisconsin were recently shipped by air to Creole Petroleum Corporation in Venezuala, South America. Shipment consisted of ten 30-in. 3-R welding elbows each weighing over 2600 lb. The Ladish Company made the fittings to meet an emergency requirement of the Tellepson Construction Company of Houston, Texas.

Lunkenheimer Announces Plans

The Lunkenheimer Company plans to consolidate and expand all manufacturing operations at the company's Fairmount plant site, Cincinnati, Ohio. A modern factory devoted to iron and steel valve machining operations will be erected. This will complement the production of bronze valves that has been centered at the Fairmount plant.

Gardner-Denver Opens Plant

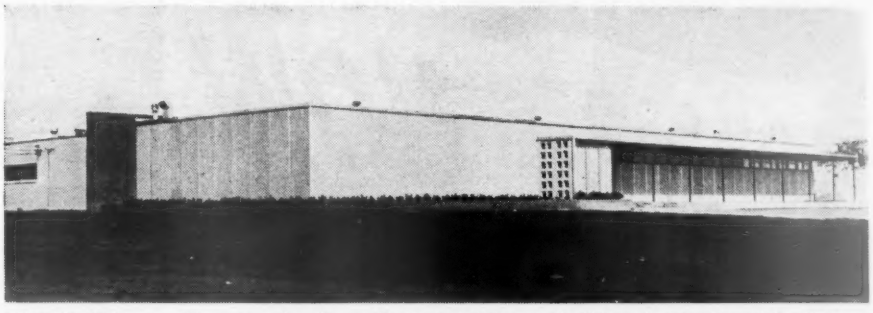
Gardner-Denver Company has moved into its new unit fabrication and warehouse building in Dallas, Texas. Plant will serve Gardner-Denvers' activities in the oil industry. Building is a one-story concrete and brick structure containing approximately 17,000 sq ft of floor space.

Tapecoat Opens Office

Opening of a west coast office in the San Francisco area to serve California, Oregon, Washington, Idaho, and Nevada, has ben announced by the Tapecoat Company. Office will be headed by L. R. "Bob" Zito, appointed district manager with headquarters at 16051 Via Toledo, San Lorenzo, California. Zito was district manager in the New York area, supervising sales and service in 12 eastern states.

Durametallic Appoints Agent

Announcement has been made by the Durametallic Corporation of the appointment of General Sales, Inc., Amarillo, Texas, as sales and service representatives. General Sales will promote the sales and application of Durametallic packings and rotary mechanical seals in the Texas Panhandle and Western Oklahoma area.



Chemical Process Company has formally opened its new building in Breckenridge, Texas. The L-shaped structure, with 10,000 sq ft floor space, houses executive and administrative offices and research, chemical and geological laboratories.

Safety Award Given

The National Safety Council announced that Western Geophysical Company of America has been presented the Council's Award of Merit for its excellent safety record. The award is presented only where an establishment's record satisfies rigid requirements laid down by the Council's award plan for recognizing good industrial safety records. Ned H. Dearborn, president of the National Safety Council, said that the company qualified for the award because of its low injury rate in 1953.

Pritchard Moves Office

J. F. Pritchard and Company has moved to its new building at 4625 Roanoke Parkway, Kansas City 12, Missouri.

Chrysler Opens Office

Opening of a regional office to assist in promotion and sale in the Los Angeles area has been announced by Chrysler Corporation Marine and Industrial Engine Division. The office, to be headed by Frank L. Harris, will be headquarters on the west coast.

BJ Tool Film Available

Premiered at the Oil Well Drilling Contractors Convention in Los Angeles, California, Byron Jackson Company's new full-color film, "Power Pays Off," has been released for group showings. Film, on power-operated tools is narrated in English only, although a Spanish version will be available shortly.

Republic Supply's $150,000 store and division headquarters opened in Houston, Texas. Building, with 32,000 sq ft of floor space, will contain supply store, warehouse, offices, sales lobby, and dormitory space for in-training personnel.

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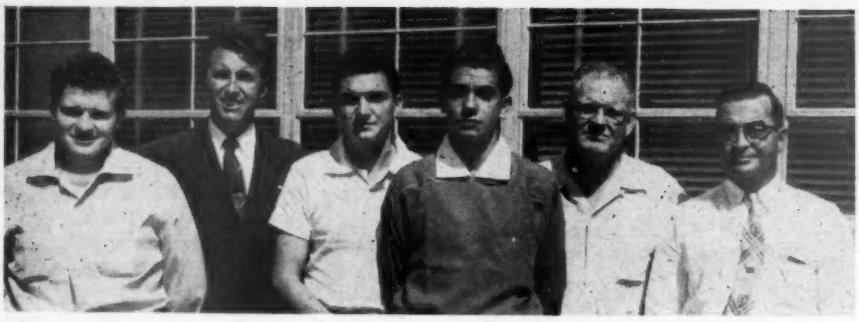

Cameron Iron Works, Inc., was host to 32 senior engineering students from the University of Mexico. Shown touring the Houston, Texas, plant are Rueben Poplawsky, University of México; Carl Houston, University of Houston; Victor Moyo, University of Mexico; Joseph Salem, University of Mexico; I. M. Baker, head of export sales in Mexico and South America for Cameron, and A. D. Cathev, export sales department.

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8 DAY
CHARTS
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ROCKWELL CHART DRIVES
EIGHT-DAY ARCCO CHARTS are now available for use on practically all Rockwell-Emco, Foxboro and Westcott orifice meters. Eight day charts for other instruments soon available.
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ROCKWELL CHART DRIVES are ruggedly built and are sealed for years of trouble-free service. The drives are adaptable to practically every type of instrument using circular charts. The price is $13.75 each. Turrets are $4.25 each F.O.B. Los Angeles, Calif. or Tulsa, Oklahoma.
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SEND FOR DRIVE AND CHART BULLETIN
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Dresser's Sales Still High

Sales and earnings of Dresser Industries, Inc., continued at high levels during the third quarter, President H. N. Mallon stated in his third quarter report to stockholders. Net earnings for the first 9 months of the current year were $5,689,903 on sales of $98,141,529. This compares with earnings of $3,246,201 on sales of $94,653,080 for the same period of 1953.

Pump Test Lab Installed

Dean Brothers Pump, Inc., has installed a modern, fully equipped pump test and research laboratory at its Indianapolis, Indiana, plant. Testing facilities consist of a closed system in which water is circulated by pump under study. Test conditions closely simulate actual conditions under which pump will operate on the job. Performance data on each pump is recorded before shipment.

Western Has Anniversary

Western Oil Company, Midland, Texas, has celebrated its fifteenth anniversary of providing technical oil well services. Company, which began with four persons, now has 10 field service points in Texas, New Mexico, Oklahoma, and Kansas, and a regional office in Wichita Falls, Texas.

Dowell Adds Pumper

Dowell Incorporated is using two 500-hp Continental gasoline engines to drive pumps in its Permian Basin fleet. It is first to make commercial use of these engines originally developed to drive Sherman and Patton tanks. Each engine drives a pump independently. Pumps will be used to fracture and acidize wells where high pressures and large volumes of fluid are handled.

Cummins Bulletin Winner

The Cummins Bulletin, sales publication of Cummins Sales and Service, Inc., has won a top award in the United States for promoting its company and products. The McCormick-Armstrong award and plaque, top prize given by the Society of Associated Industrial Editors, was presented to editor Victor LeMay. Two other honors won by the magazine were for all-around editorial achievement. Another magazine published by LeMay for Mid-Continent Supply Company, The Mid-Continent News, received SAIE's award of merit. Jack Ripper is assistant editor of the two publications.

Jones and Laughlin Move

Jones and Laughlin Steel Corporation, supply division, Odessa, Texas, has moved to 1509 West Second Street. The new building, with 15,727 sq ft of floor space on 6-in. reinforced concrete, has a steel trussed roof spanning entire area, providing unobstructed support for traveling cranes. A private spur from Texas and Pacific tracks leads past loading dock into steel warehouse with 5000 sq ft of ground space.

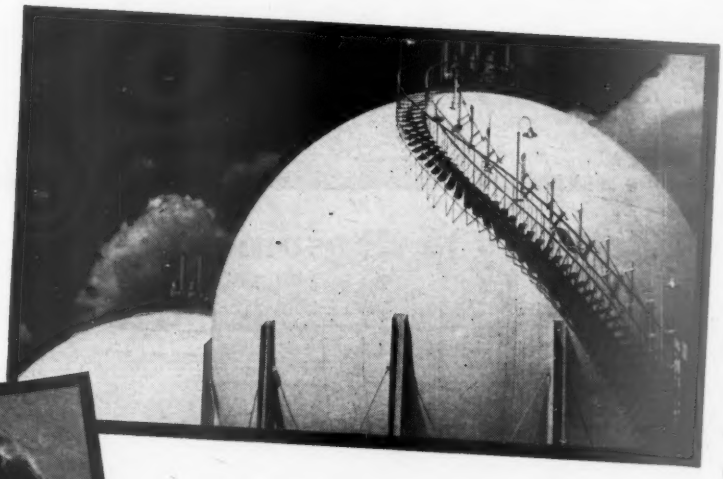
Transistor Developed

Texas Instruments, Inc., is the manufacturer of the high gain transistor used in the first commercial transistorized radio, which was developed by Industrial Development Engineering Associates, Inc. Transistor, used in the new type radio, is said to make possible the long predicted transistorization and miniaturization of mass production consumer devices.

Get 3-way savings with

DULUX TANK WHITE

REG. U.S. PAT. OFF.



CUT EVAPORATION LOSSES

Now...save up to 8 out of every 10 gallons previously lost due to evaporation! DULUX Tank White Enamel reflects the sun's heat rays effectively . . . keeps tank interiors cooler. As a result, the premium quality as well as the quantity of your stored products is protected.

CUT APPLICATION COSTS

with DULUX Tank White Enamel, you can apply *two* coats of paint in *one* operation! The first coat may be followed immediately by a second, sprayed at right angles to the first. You need only one scaffold set-up! You save time . . . you save money!

LENGTHEN PAINTING CYCLES

Weatherometer test, shown above, helps Du Pont chemists perfect longer-lasting, more rugged finishes. DULUX Tank White Enamel resists corrosion, industrial gases and rough weather . . . *keeps* your tanks sparkling white for years. Many users report 7 to 8 years of service from DULUX!

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Petroleum Industry Finishes

Du Pont has the *right* finish for every petroleum industry need

PRODUCTION • PIPELINE • REFINING
MARKETING • MARINE

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

SEND FOR FREE BOOKLET. BEAT THE HEAT is an informative, illustrated booklet that tells how Du Pont DULUX Tank White Enamel can help you save money. Send for your free copy today.

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Please send me, free of charge, your illustrated booklet BEAT THE HEAT.

*Name*_____

*Title*_____

*Firm*_____

*Address*_____

*City and State*_____

To obtain more information on products advertised see page E-37

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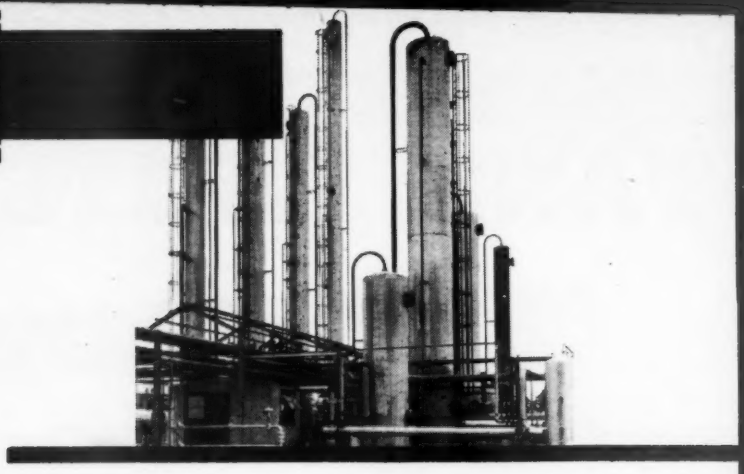

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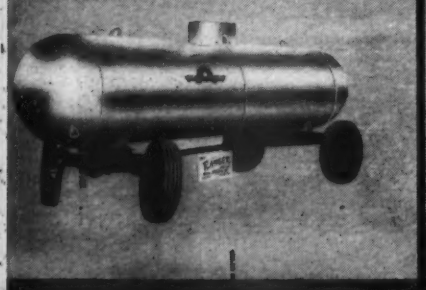
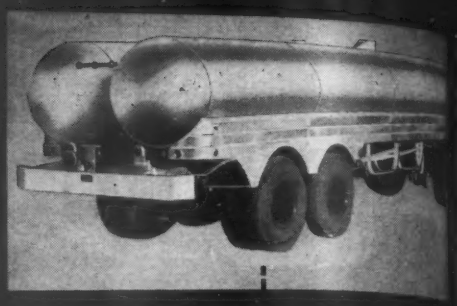
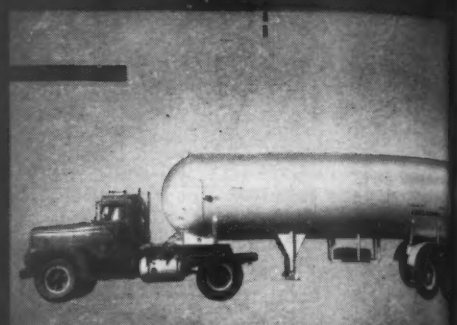


Consumer

Local Delivery



Transportation



Transportation

Transportation

Storage

Local Delivery

XUM

TRADE PERSONALS

Robert J. Stein has been appointed manager of the Dayton, Ohio, office of the government contract division of Allen B. Du Mont Laboratories, Inc. He will represent company in matters pertaining to government and special contracts throughout the mid-west. Stein attended Denison University in Granville, Ohio.

Robert L. Sink, assistant director of engineering, Consolidated Engineering Corporation, Pasadena, California, has been named chairman of the Institute of Radio Engineer's Professional Group on Instrumentation. Sink will serve as head of the 2200 member national professional society during 1954-55. A registered electrical engineer, he holds degrees in radio communications and electrical engineering from Stanford University.

G. A. Burns

C. E. Grant

G. A. "Greg" Burns, after more than 41 years of service with the Butler Manufacturing Company, the past 7 years as a vice president, has resigned as manager of Butler's Oil Equipment division. He will continue to serve as a vice president and manager of the Special Products division, and handle special assignments for Butler. Burns began his Butler career at the company's Minneapolis plant in 1913.

Charles E. Grant has been named the new manager of Butler's Oil Equipment division. Grant was formerly assistant manager. He will administer the sales operations of all four sections of Butler's Oil Equipment division: truck tanks and trailers; bolted tanks; liquefied petroleum gas systems; and welded tanks.

M. M. Wilson of the Baldwin-Hill Company, Trenton, New Jersey, was elected president and chairman of the board of the Industrial Mineral Fiber Institute, Inc.

W. D. Myers, Jr., of The Eagle-Picher Company, Cincinnati, Ohio, was named vice president and **J. A. Corcoran, Jr.,** of Forty-Eight Insulations, Inc., Aurora, Illinois, was appointed treasurer of the Innois, was appointed treasurer. Directors are **G. J. Christner** of The Eagle-Picher Company, **H. E. Lewis** of M. H. Detrick Company, **N. L. Morell** of N. L. Morell, **E. R. Stevens** of Baldwin-Hill Company, and **Frank Christenson** of Refractory and Insulation Corporation.

George P. Daley has been appointed export sales representative in the South American countries of Colombia, Ecuador, Peru, Chile, and Bolivia for Continental Supply Company. Daley joined Continental six years ago and for the past two years has served as city salesman in Houston, Texas.

D. F. McCandlish, manager of the Air Reduction Sales Company district office in Chicago, has been appointed regional manager of the North Central region in Chicago. He succeeds **S. H. Newburn** who was recently appointed president of Air Reduction Canada Limited. McCandlish joined Airco in 1931 as a salesman in the Los Angeles district. He was appointed manager of the Chicago district. **S. S. Bruce, Jr.,** succeeds McCandlish as Chicago district manager.

W. W. Littlefield, assistant sales manager of the Oklahoma district, Air Reduction Sales Company, has become manager of the El Paso, Texas, district succeeding **H. F. Colt, Jr.,** who was appointed Eastern Zone manager of the Railroad department. **W. M. Champion,** salesman in the Oklahoma office, succeeds Littlefield.

Raymond H. Matthews has been appointed chief engineer of Fenwal, Inc., Ashland, Massachusetts. He will administer the company's engineering staff which includes a group of 20 engineers and designers. Matthews joined Fenwal in 1951 and for the past year had served as assistant chief engineer. He obtained his degree in mechanical engineering from Worcester Polytechnic Institute in 1943.

V. L. Gallia, who has been sales and service engineer for Lufkin Foundry and Machine Company in Brookhaven, Mississippi, since July 1949, has been transferred to the Houston office in the Gulf Coast division as service manager. He was previously in the Houston office as service engineer for the Gulf Coast division.

C. K. Madison

R. R. Bush

Carl K. Madison, midwestern regional manager of Rockwell Manufacturing Company, has been promoted to vice president in charge of new product sales for the entire midwestern division. Madison joined Rockwell in 1929 as sales engineer.

Roy R. Bush, Tulsa, Oklahoma, district manager, has been named mid-western regional manager with headquarters at Tulsa.

W. R. McLaughlin, manager of the Dallas, Texas, office, becomes southwestern regional manager with headquarters at Dallas. Bush joined the Rockwell sales staff in Tulsa in 1934. McLaughlin joined the company in 1934 as a sales engineer in Dallas. In 1952 he was named manager of the Dallas office.

Turbine Equipment Company, New York, New York, has advanced **Harold Sinclair** from president to chairman of the board and **Donald F. Miller** from executive vice president to president. **Paul E. Linthwaite,** formerly sales engineer, has been made vice president in charge of machinery sales for the company. Sinclair joined Turbine in 1912 after studying mechanical engineering at Cornell. He was made vice president of the company in 1930 and president in 1947. Miller, who attended Lafayette College, was made vice president in 1937 and executive vice president in 1952. Linthwaite was graduated from Northeast University. He has been with Turbine Equipment since 1938, except for the war period.

J. R. Howell

John R. Howell has been named sales manager and director of Sterling Electric Motors, Inc. He has been associated with Sterling Electric more than 25 years. Howell will direct 24 district offices and more than 400 distributors and service representatives.

Edgar F. Whitmore, Jr., has been elected vice president of Shippers' Car Line Corporation, **S. M. Felton,** president, announced Whitmore, formerly assistant vice president, will be in charge of company's Illinois, territory, succeeding the late **A. W. Johnson.** Previously associated with the Aluminum Company of America, he is a graduate of Lehigh University and Harvard Graduate School.

Rudolf Torbico has joined the Carboloy department of General Electric Company as a field sales representative. Torbico, who holds a BS degree in industrial management from the University of Akron, Akron, Ohio, was previously with Ford and General Motors.

W. R. McLaughlin

W. L. Krapf

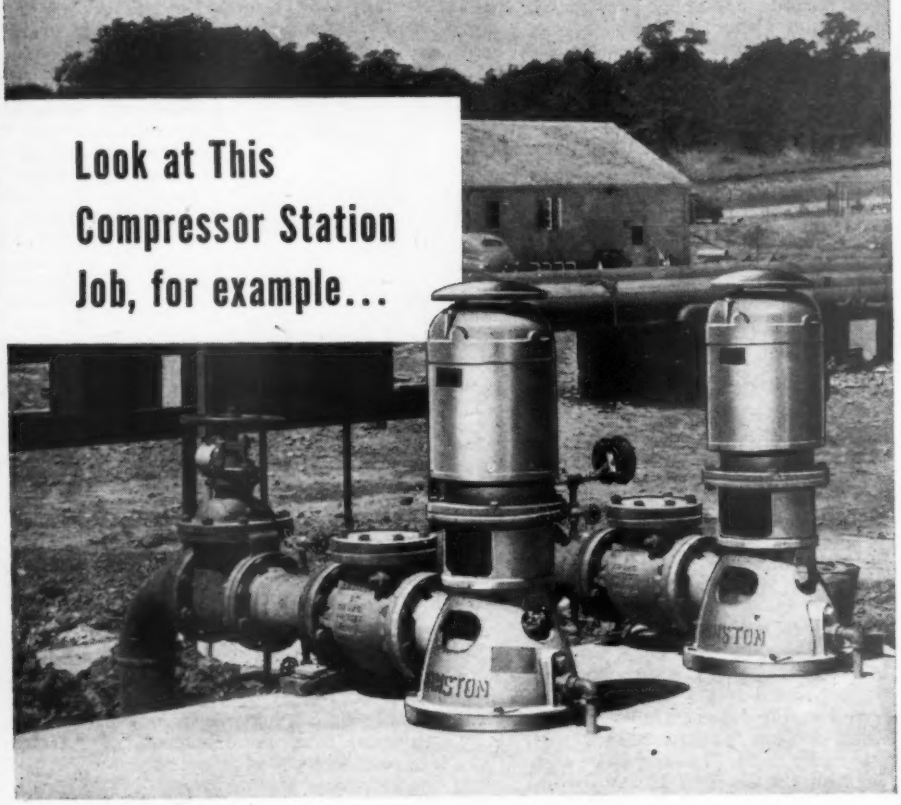
Bulkley, Dunton Processes, Inc., manufacturers of Colloidair Separators for industrial waste water treatment, has announced the appointment of **William L. Krapf** to the post of general manager. For the past three years Krapf was assistant to the executive vice president of the New York firm.

Prior to joining Bulkley, he was a sales engineer for United Board and Carton Company, and Bulkley, Dunton Pulp.

Donald F. Brickley has been named manager of Motorla Communications and Electronics Division's region 1. Brickley joined the parent company, Motorla Incorporated, in 1937 as a production employee. He was zone manager in northern Illinois before his promotion.

XUM

DEPENDABLE, EFFICIENT JOHNSTON PUMPS *offer many advantages*



Look at This Compressor Station Job, for example...

JOHNSTON TURBINE PUMPS

These two Johnston Close-Coupled Pumps are recirculating 130°F. water through a cooling system at an Oklahoma Natural Gas Company pipeline compressor station. Installed in September, 1950, these units are 5 horsepower, single stage, 10 inch pumps with open line shaft and 5½ feet of 6 inch discharge column. Each unit delivers 600 gallons per minute against a head of 30 feet.

Engineers of Oklahoma Natural Gas Company wanted more than high efficiency out of the pumps for this job. They wanted pumps that would give no priming problems, that would be easiest to maintain and would require as little floor space as possible.

The Johnston Pump Dealer in Tulsa recommended the pumps that were finally selected for this job, because they met all the requirements BETTER than any other pump.

For complete information about Johnston Pumps and the name of your nearby Johnston Dealer, mail the coupon today.

JOHNSTON PUMP COMPANY

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Pasadena 15, California

☐ Please Send Bulletin
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PE 124

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City_____ Zone____ State_____

Trade Personals

A. G. Lindquist

R. L. Dailey

Roger L. Dailey has been appointed division manager of the Eastern division of The National Supply Company, manufacturer and distributor of oil field machinery and equipment. He succeeds **William Van Vleet,** who will handle major accounts in the Pittsburgh area. Dailey joined National Supply in 1922 as a field salesman in Okemah, Oklahoma. The Eastern division, with headquarters at Toledo, includes the Kentucky and West Virginia District, the New York and Pennsylvania District, the Ohio District, and the Illinois and Michigan Districts.

A. G. Lindquist, secretary and comptroller of Gardner-Denver Company, has been elected vice president of the company. Lindquist, who has been associated with Gardner-Denver for the last 16 years, will continue as secretary and comptroller in addition to his new duties.

Eddie Chiles is president of the Western Company of Midland, Texas, which has observed its 15th anniversary of providing technical oil well services to the petroleum industry. In the early days of the company President Chiles was one of four employees and doubled as chief engineer. Seagraves, Texas, was selected as the site for the first Western station in 1939. Western's early field fleet consisted of two acidizing trucks and a passenger car. Today company maintains ten field service points and a regional office.

Eddie Chiles

W. R. Bays, former Kansas sales representative of the Detroit diesel engine division of General Motors, has been appointed the distributor for GM diesel engines in Western Kansas. The new distributor has taken over the facilities of Detroit Diesel's former distributor, the Diesel Equipment Company of Wichita and Great Bend. **C. J. Davy,** previously sales representative for the division in a southeastern zone, temporarily will handle the zone sales representative's assignment in this area.

William Bennett has been appointed general manager; **William Daniels,** sales manager; **Robert Abbott,** service manager and **C. W. Hamilton,** parts manager, all of whom were employees of the former distributor. **J. D. Jarvis,** who formerly operated Diesel Equipment Company, has retired from the Diesel engine business to devote full time to his manufacturing interests.

Appointment of **Carl J. Koelsch, Jr.,** as associate director of purchases of Trailmobile, Inc., has been announced. Koelsch will co-ordinate purchasing activities of Trailmobile with **W. H. French.**

S. G. Paddock

F. K. Becker

H. L. Harris

W. F. Wood

S. G. Paddock, formerly sales manager for the Dallas, Texas, division of Burgess-Manning Company, has been named the Dallas division manager and director of a new national sales organization. Paddock will direct and correlate sales operations of the company's divisions at Libertyville, Illinois, and Dallas, with three primary sales districts.

Frank K. Becker has been named manager of the Dallas district, which includes southwest and southern far west territories, with sales agencies in Tulsa, Houston, New Orleans, Denver and Los Angeles. The Dallas district specializes in engineering and service in the petroleum, chemical and general industrial fields. **H. L. Harris** has been named to assist in Dallas district sales.

H. A. Dietrich has been named manager of the Chicago district, which comprises the middle west and northern far west. As district manager he will continue his divisional administrative duties, including direction of advertising. **F. C. Duerr** has been assigned to Chicago district sales.

W. A. Carroll, Jr., has been named district manager of the New York district, comprising the eastern states and the Pittsburgh territory. **R. T. Oliver, Jr.,** has been assigned to New York sales.

F. M. Thuney, former Washington, D. C. branch manager, has been promoted to manager of the contract division in Minneapolis-Honeywell Regulator Company's Industrial division plant at Philadelphia, Pennsylvania. **J. W. Bowers,** former Grand Rapids, Michigan, manager has been named to head a newly-created department of service and repair of controls for commercial establishments. He will make his headquarters in Minneapolis.

Harry E. Grossman replaces Thuney as manager of Honeywell's Washington branch and **Joseph H. Nixon** will head the firm's Grand Rapids district office. Grossman was formerly manager of the company's Harrisburg, Pennsylvania office while Nixon was previously senior commercial salesman in Saginaw, Michigan.

Other new managers named include **Wayne F. Kelly** who replaces **George Dieter** as manager of the Spokane, Washington branch; **T. S. (Sid) Bolling,** assigned to the Charleston, West Virginia district office and **Charles W. Prey** named to head the Harrisburg district office. Kelly was formerly senior commercial salesman in Youngstown, Pennsylvania and Prey previously headed the company's commercial sales activities in Baltimore.

Additional field assignments announced include **Leight M. Johnson,** former senior commercial salesman in Philadelphia, to branch commercial sales manager in Harrisburg and **Raymond A. Metz,** former senior commercial salesman in Wilmington, Delaware to a similar post in Philadelphia.

The Ric-Wil Company of Barberton, Ohio, announces the appointment of **William F. Wood** as general sales manager. He was formerly district manager in charge of the Washington, D. C., office and has been with Ric-Wil for the past 16 years. A graduate of the University of Omaha, he is a member of the American Society of Heating and Ventilating Engineers and the Armed Forces Chemical Association. He replaces **C. W. Wheeler,** who is retiring.

Lane-Wells Company has announced the following supervisory changes in the Gulf Coast division. **T. W. Lindsey,** formerly sub-district superintendent at Victoria, Texas, has been transferred to Hobbs, New Mexico, as sub-district superintendent there. **G. K. Chandler,** formerly station superintendent at Falfurrias, Texas, has been appointed sub-district superintendent at Victoria. **J. W. Maurice, Jr.,** formerly sub-district superintendent at Hobbs, New Mexico, has been transferred to Falfurrias, Texas, as station superintendent.

The election of **T. J. Ault** as president and general manager of the Long Manufacturing division of Borg-Warner Corporation, in Detroit, has been announced. **J. Rodger Dryden,** formerly president and general manager of Long, becomes chairman of the board of the division, succeeding **J. Lester Dryden,** who is retiring. Ault also retains the position of president and general manager of Borg-Warner's Detroit gear division.

The retirement of three other Long division executives also was announced. They are **M. J. Brinkman,** formerly executive vice president; **L. J. Loranger,** formerly a vice president; and **W. F. Burgess,** formerly secretary and treasurer. **Royden Walters,** secretary and treasurer of Detroit Gear, will now serve also as secretary and treasurer of Long.

The Trane Company has announced the appointment of **George C. Wilson** as assistant development engineer in the engineering department, heat transfer section. Wilson received a BE and MS degree in mechanical engineering from the University of Southern California in addition to an ME degree from Stanford University. His past employment experience was with the University of Southern California and with North American Aviation in Los **Angeles.**

Election of **Clyde C. Williams** as vice president of sales of Chrysler Corporation's marine and industrial engine division has been announced. Associated with Chrysler Corporation for 26 years, Williams was assigned to the marine and industrial engine division during World War II. In April, 1946, he was appointed manager of marine sales, and since December, 1950, he has served as the general manager of the entire division.

R. L. McAnally

K. W. Davis

P. Z. Hilliard

Director of Purchases **P. Z. Hilliard** and West Texas-New Mexico Division Sales Manager **R. L. McAnally** were presented 20-year service awards by Mid-Continent Supply Company President **Ken W. Davis.** Hilliard began his Mid-Continent service in Lake Charles, Louisiana. He and McAnally opened the original Mid-Continent store in Kermit, Texas, in 1935. McAnally has worked during his entire Mid-Continent career in West Texas and New Mexico. In addition to his job as division sales manager, he also heads Mid-Continent operations in the San Juan Basin. Hilliard and McAnally both joined Mid-Continent in 1934.

McCullough Tool Company has announced the appointment of **Al Simpson** as a sales engineer at its Bakersfield, California, branch service location. He received his Master's degree in Geology at the University of Southern California. Prior to his appointment as a sales engineer, Simpson had worked as a logging engineer and geologist at McCullough's headquarters at Los Angeles since 1950.

The appointment of **Harvey A. Craig** as manager of sales of the Bolt and Nut Division, Republic Steel Corporation, has been announced. Craig, who has been Pacific Coast sales manager for Republic Steel, will succeed **Robert C. Klemm** who is making plans for his retirement at a later date. Klemm will continue with the Bolt and Nut division in an advisory capacity with the title of assistant manager of sales and will be in charge of certain special assignments. Craig joined the Republic organization in 1943 as manager of the Los Angeles sales office.

The appointment of **Henry A. Bourne** as Pacific Coast sales manager has been announced. **Curtis C. Snyder,** assistant district sales manager for Republic at Los Angeles, will become the sales manager in that location. Bourne was formerly district sales manager of Republic's Tulsa, Oklahoma, sales office. He is a graduate of the Wharton School of Finance at the University of Pennsylvania. Snyder attended Ohio State University. He has been associated with Republic and its predecessor companies since 1921.

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NEW oil and gas Equipment

- Machinery
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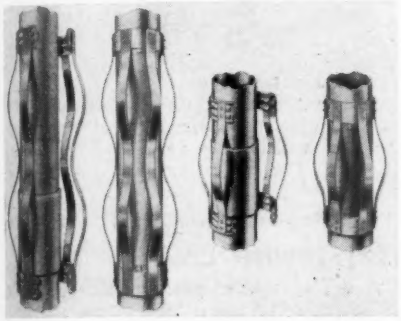
For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

(1) CASING CENTRALIZERS

A new design centralizer said to take 45 per cent less permanent set than the standard maximum allowance and to provide 300 per cent more initial centering force than the standard minimum requirement, has been announced by Larkin Packer Company, Inc. Centralizers are offered in five ranges and four types—the long and short Lok-On and the long and short Slip-On. Each of the five ranges of Larkin centralizers is designed to give the operator the correct centering force with any length or size pipe. The short



Lok-On centralizer is designed for centering shorter strings of casing in undeviated holes. The long Slip-On centralizer is a counterpart of the Lok-On with the exception that it is always positioned between the casing couplings rather than around them. The short Slip-On is designed for "between the couplings" installation on shorter strings in undeviated holes.

Circle number (1) on reply card.

(2) CONNECTION

A new connection which offers industry "one specification" connection for all piping applications and pressure ratings has been developed by Gray Tool Company. It requires no selection of gaskets, facings or bolts, all parts being fully interchangeable and re-usable. Named the Graloc, the connection employs a two-bolt clamping principle and a stored energy seal. The standard Graloc connection is about one-half the weight of a comparable 300-lb flanged connection, and one-eighth the weight of a 2500-lb flanged connection. The outside diameter and length of connections are less than 150-lb ASA flanges. Standard Graloc connections are made in 3 styles.

Circle number (2) on reply card.

(3) WIRE ROPE

A wire rope with a crush resistant steel coil is being produced by Jones and Laughlin Steel Corporation. An Oklahoma firm used a one and a quarter-inch SpringKore in drilling a 12,765-ft oil well, where the tensional load of the drill pipe at times exceeded a quarter of a million pounds. The rope gave 46,376 miles of service.

Circle number (3) on reply card.

(4) DRILL COLLAR SPEAR

Tri-State Oil Tool Company has designed a new drill collar spear said to overcome the hazard of dropping a heavy string of drill collars or drill pipe, which is stuck off the well bottom, while washing over the stuck section. Spear is installed inside the washover pipe at a desired point so that it may be screwed into the fish before the rotary shoe reaches the stuck point. After the joint is securely tightened the working string is turned about one-eighth turn to the left and lowered. This operation is planned to release the tool from the control bushing, so that when the fish is washed free it will be securely caught.

Circle number (4) on reply card.

(5) SELF WINDING REEL

A new 150-ft self winding reel for welding hose has been announced by United Specialty Corporation. Known as Model OAB, the reel features large hose capacity, spring and gear retracting action, a catch for locking hose at desired length, and bracket for mounting in any desired position.

Circle number (5) on reply card.

(6) ELECTRODE

A new electrode for welding high tensile strength joints has been announced by The Lincoln Electric Company. Electrode, called Jetweld 2 HT, contains iron powder in the coating which gives it the advantages of speed and performance associated with this new type electrode. It is especially designed for high speed welding of flat and deep groove joints where high tensile strength and low crack sensitivity are required.

Circle number (6) on reply card.

(7) ROLLER BEARINGS

Rollway Bearing Company, Inc., has manufactured a bearing that features a steel segmented type of cage that provides sufficient strength and accuracy to retain and guide the crowned rollers at high speeds. Bearing is easily assembled. After heating its inner race in oil to approximately 250 F, it can easily be slipped on the motor rotor shaft during preliminary assembly stages. Dimensions are: Bore 4.53-in., outside diameter 9.84-in., width 3.08-in.

Circle number (7) on reply card.

(8) MOISTURE TRAP

V. D. Anderson Company has made available its No. 81 float-type moisture trap. Well designed and compact, unit is said to have good capacities for its size and is designed as a low cost method of draining moisture and condensate continuously and automatically from piping systems, Hi-eF purifiers and other equipment which handle air, gas or steam.

Circle number (8) on reply card.

(9) PUMPING UNIT

A 10 ft stroke model incorporating all the design features and advantages of their 6 ft stroke models has been added by S. C Carter Company, Inc., to its line of hydraulic pumping units for stripper wells. Specifications of the new model are: Cylinder size 4½-in. ID, 10-ft stroke; tank capacity 100 gal; jackshaft diameter 1 7/16 in.; standard pump model V144; shipping weight 1150 lb; net piston area 14.9 sq in.; piston displacement 7.74 gal; maximum operating pressure 750 psi; maximum polished rod load 11,000 lb, and maximum spm 3.3.

Circle number (9) on reply card.

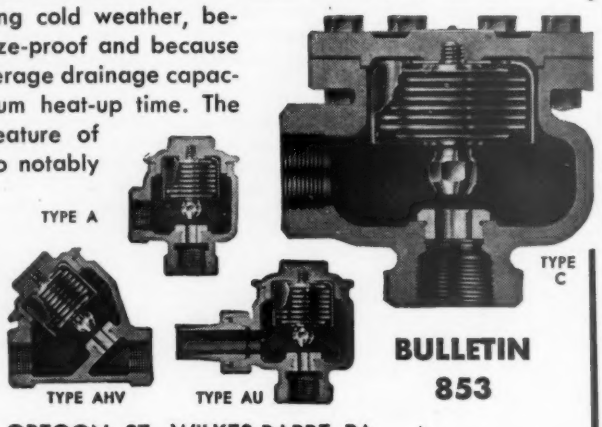
Driller checks condition of SpringKore on drum on Oklahoma rig.

NICHOLSON MAKES

Freeze-Proof Steam Traps

for every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates heat transfer in severe weather. Types for every plant use. Sizes ¼" to 2"; pressures to 250 lbs.



BULLETIN 853

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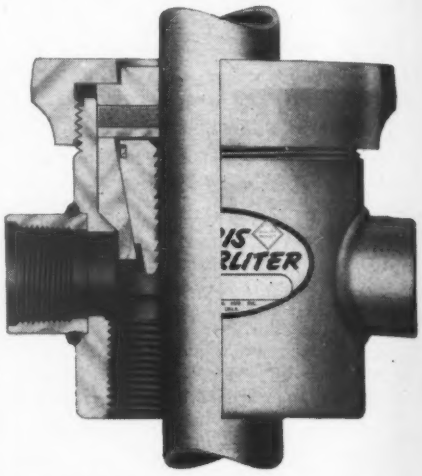
New Equipment

(10) WCN TUBING HEAD

Rated at 1000 CWP, W. C. Norris Manufacturer's Type WCN head is said to be adaptable to fracturing, acidizing, repressuring, water flooding, and various other completion and production methods. Full opening, equipped with slips to suspend 2 or 2½-in tubing, the WCN head



is furnished in 5½-in. female casing size, with two 2-in. side outlets. Also available in 7-in. male casing size. Overall height of the 5½-in. head is 8⅜-in.; 7-in. head, 10⅞-in. The adjusting cap provides a broad tubing spider base.

Circle number (10) on reply card.

(11) TUBING CALIPER

A device said to perform the function of actually "taking a look" inside tubing extending miles deep, and reporting corrosive pitting to the thousandth of an inch has been developed by Otis Pressure Control, Inc. The caliper fits inside the tube exactly, by means of a spring mechanism that presses lever arms against the tube wall. Each time a worn spot or pit is encountered, the arms expand, actuating a stylus which plots a continuous graph of depressions in the tubing. Caliper can be used without interfering with the flow of the well.

Circle number (11) on reply card.

(12) HEAT TRANSFER UNIT

Tranter Manufacturing, Inc., by using new metals in the construction of Platecoil, a heat transfer unit, has broadened the application of the product. Unit was previously made of cold rolled steel, stainless steel, and monel. Use of the new metals means the units can be made resistant to a much wider range of corrosive media. Tests indicate the whole range of materials can provide Platecoils resistant to more than 200 corrosive media.

Circle number (12) on reply card.

(13) INDICATOR

A panel-mounted indicator for continuous measurement of pH or redox in manufacturing processes is offered by Leeds and Northrup Company. Company states that the instrument is moisture-proof and gives accurate readings after less than a one-minute warm-up, without the use of desiccants, also that the indicator is unaffected by line voltage surges, electrical pick-up, and zero drift. The a-c operated instrument can be used as a continuous indicator, with or without extra meter assemblies to duplicate readings.

Circle number (13) on reply card.

(14) PILOT PLANT ASSEMBLY

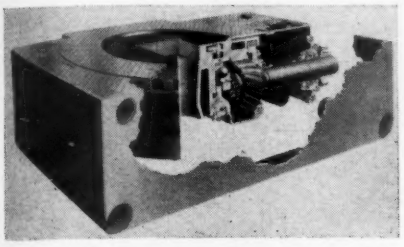
A complete, semi-pilot plant assembly is now available from Industrial Process Engineers. The entire IPE Unit is shipped preassembled or in match-marked parts, for simple installation. It requires less than 55 sq ft of floor space, and is only 12 ft in height.

Assembly includes these basic components: A 25 gal, jacketed reaction vessel, jacketed column that can be packed or left empty, shell-and-tube condenser, condensate pump, a control panel, and two 15 gal receivers.

Circle number (14) on reply card.

(15) ROTARY MACHINE

Unit Rig and Equipment Company is manufacturing a rotary table with extra protection against mud penetration as well as a table said to be dynamically balanced



during final factory run-in and inspection. The dynamically-balanced table is designed to eliminate primary stress and strain resulting from imbalance vibration and has no surface projections.

Circle number (15) on reply card.

(16) WATER TANKS

The Permaglas Division of the A. O. Smith Corporation has announced the introduction of a line of glass-lined water storage tanks. Initially these tanks will be stocked in five sizes ranging from 100 to 350 gallons. Larger sizes will be available to meet specific installation and design requirements. The glass coating will be the same quality as the domestic heaters and will have the same type of magnesium anode rods.

Circle number (16) on reply card.

(17) TRUCKER'S BLOCK

LeBus Rotary Tool Works is producing a "trucker's" snatch block. Block is manufactured for use in all fields of light or heavy hauling, construction, or rigging work. A new type of threaded bolt pin or yoke pin is said to offer positive and safe locking facilities. A triple locking feature is incorporated in its operation to prevent possible loss through truck vibration. Carbon and alloy steels are used in the construction of the block, with all parts being drop forged, heat-treated and processed in a manner said to withstand the very heaviest of operations. Blocks are available in 5 sizes: light duty 6 in., heavy duty 6½ in., 8 in., 8½ in., and 10½ in.

Circle number (17) on reply card.

(18) RUST CONVERTER

Municipal Steel Corporation, chemical division, has announced the availability of FerRoSeal, a liquid which chemically converts rust into a protective iron phosphate coating. Product is said to be the only cold phosphating treatment for rusted iron and steel. One gallon of FerRoSeal is said to cover a metal surface area of about 1000 to 1500 sq ft, depending upon the thickness of the rust layer.

Circle number (18) on reply card.

Cooling jacket on pipe line dope cooler.

(19) PIPE LINE DOPE-COOLER

A pipe line dope cooler, which cools coated pipe so that it can be laid immediately, has been developed by Crutcher-Rolfs-Cummings, Inc. The CRC truck-mounted cooling tower is towed behind the dope kettle, and the cooling jacket follows the CRC coating and wrapping machine. A 6-ft-long cooling jacket with spray nozzles fits around the pipe. After the protective coating is applied to the pipe, the cooled water is sprayed onto the coating then returned to the tower for recooling. Two pumps, one discharge and one suction, pump the water to the cooling jacket and return it to the cooling tower. The asphalt dope has a temperature of above 450 deg when applied to the pipe. The cooled water is said to lower the temperature of the freshly coated pipe approximately 300 deg at the rate of 60 fpm, allowing it to be lowered immediately without waiting for cooling.

Circle number (19) on reply card.

(20) DIESEL GENERATOR

A new 1500/2000 watt diesel generator set is being manufactured for marine oil field use by Stewart and Stevenson Services. The diesel light plant is 31 in. high by 24 in. wide by 39-in. long and weighs 550 lb. It is built in 32 v dc or 110 v dc.

Circle number (20) on reply card.

(21) HOT SPRAY HEATER

Spee-flo hot spray portable 600 has been designed to operate in chemical plants, oil fields, refineries, shipyards, steel mills and wherever protective coatings are applied. The Portable 600 is said to bring the advantages of heated application into outdoor maintenance work for use with all types of sprayable coatings. An average estimated labor saving of approximately 35 per cent in square foot coverage is predicted. Spee-Flo portable operates with standard pressure tank or pump and may be elevated on a scaffold or operated at ground level. Its heavy duty, 2000 watt, UL approved heater and motor is designed to maintain hot material at the spray gun at a capacity of 15 gal per hour and for distances up to 50 ft from the heater.

Circle number (21) on reply card.

(22) "AUTOMATED" BATCHING

Economies of automation have been applied to the handling of light and heavy liquids in batch quantities through the fluidometer system developed by Hetherington and Berner, Inc. It consists of a Rockwell rotocycle measuring element, a motor-operated control register, and a solenoid valve. To operate, a control dial is set to the desired amount of liquid to be passed through, and a "start" button is pushed which opens the valve and allows the liquid to pass through the meter. The meter drive shaft is directly coupled to the control and turns the hands to the zero point. At zero, the controlling element automatically closes the valve and returns the hands to the previous setting. The starting push button can be eliminated by the substitution of a timing device. In using highly viscous liquids, piping, meters, and valves are jacketed.

Circle number (22) on reply card.

(23) HIGH PRESSURE VALVE

A new high pressure combination reducing and automatic relief valve has been designed for low capacity applications by Atlas Valve Company. Atlas' type "F" reducing and relief valve was designed to be used for initial pressures as high as 4000 psi and reduced pressures from 2000 psi down to 0 psi in accurately controlled adjustable increments. Valve is available in ⅛, ¼, ½, and ¾-in. sizes.

Circle number (23) on reply card.

(24) SR-4 CELLS

SR-4 pressure cells, specially designed for rough handling by pipe fitters and to meet the requirements of oil pipe line service, are announced by Baldwin-Lima-Hamilton Corporation. This cell (Type B-1) is similar to the standard Baldwin cell but includes special features such as a heavy steel case and welded assembly. Stronger signals for the remote pressure-measuring, controlling, and telemetering equipment used in controlling pipe line operations are provided by increasing electrical output. Eight sizes from 100 to 2000 lb psi are available.

Circle number (24) on reply card.

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The Centrifugal Casting and "Heat Tensioning" methods used by France have proved: here are Piston Rings that assure you longer life and efficient oil control with no warping or loss of tension in service.

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MAXIMUM SERVICE for you in our NEW PLANT

FRANCE PACKING COMPANY

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(25) NEEDLE VALVES

New line of forged needle valves with universal outlets featuring micrometer thread stainless steel stems for fine metering is announced by Carpenter Valves Corporation. Known as "bull-dog" needle valves, the bodies are forged from brass, stainless steel, or carbon steel. It is claimed by the makers that the wide range of optional machinings on outlets facilitate lower-priced neat installations. Valves are also furnished in mountings for instrument panels.

Circle number (25) on reply card.

(26) PIPE AND CABLE LAYER

Specially designed to install flexible pipe and cable underground, Ferguson pipe and cable layer is designed to eliminate hand-digging or machine trenching. Tool, which attaches to tractor, is said to handle flexible pipe ½ to 1½-in. in diameter, and heavy-duty electrical cable; install pipe or cable up to 18-in. deep, have adjustable roller bracket on base to keep pipe or cable on bottom of slit for maximum depth; and to leave the ground level without backfilling.

Circle number (26) on reply card.

(27) PIPE CUTTER

A heavy duty 6-roller pipe cutter is announced by the Toledo Pipe Threading Machine Company. It is specially designed with six rollers to prevent spiraling when used with power drives. Capacity ⅛ to 2-in. pipe. Features designed to save time and improve performance in cutting operations include simple modern design, rollers in hook to provide true alignment and assure square cut-off, and frame formed to fit the hand and guaranteed warp-proof. High alloy steel cutter wheels are said to leave practically no burr.

Circle number (27) on reply card.

(28) CAM CLUTCHES

A new line of cam clutches for indexing applications in a wide variety of machinery drives is available from Morse Chain Company. Designated as the Morse Series HT Cam Clutches, this new line of self-contained units includes a single row ball bearing that helps maintain concentricity of the inner and outer races. Series HT clutches are designated for application on stepped shafts in machinery drives. Typical applications for these indexing clutches include feed rolls, spring coilers, metal forming equipment, dual drives, and two-speed applications. Clutches feature constant pitch spacing and alternate cam and roller construction to provide accurate indexing operation. They can be supplied for either right or left-hand drive depending on customer requirements.

Circle number (28) on reply card.

(29) V-12 POWER UNIT

Waukesha Motor Company's Model VLR series 12-cylinder power unit is available for use with propane-butane or natural gas fuel, and as a full diesel with normal aspiration or turbo-supercharged. Unit is a high compression, overhead valve, 60-degree vee, 4-cycle engine, with 8½-in. bore and stroke, and 5788 cubic inch displacement. Operating on butane-propane, it develops approximately 870 hp with radiator, fan, and air cleaners. Unit ratings of the normal diesel and the turbo-charged diesel are approximately 800 and 1100 hp, respectively. Maximum speed is 1200 rpm.

Circle number (29) on reply card.

FIELD TESTED AND APPROVED

JET-LUBE APPLICATOR

For Applying Lubricants to Tool Joints, Drill Collars, Drill Tubing, Casings and Tubing

√ prevents contamination
√ reduces lube consumption
√ cleaner and safer
√ quicker round trips
√ increases service life
√ measured lubrication
√ drum off working floor

JET-LUBE APPLICATORS will pump any kind of lubricant which will seek its own level . . . which will not settle out under vibration . . . and which can be pumped at sub-zero temperatures.

JET-LUBE's "550", "21" and KOPR-KOTE meet all these requirements

Write for Technical Bulletins on Jet-Lube Applicator and Compounds

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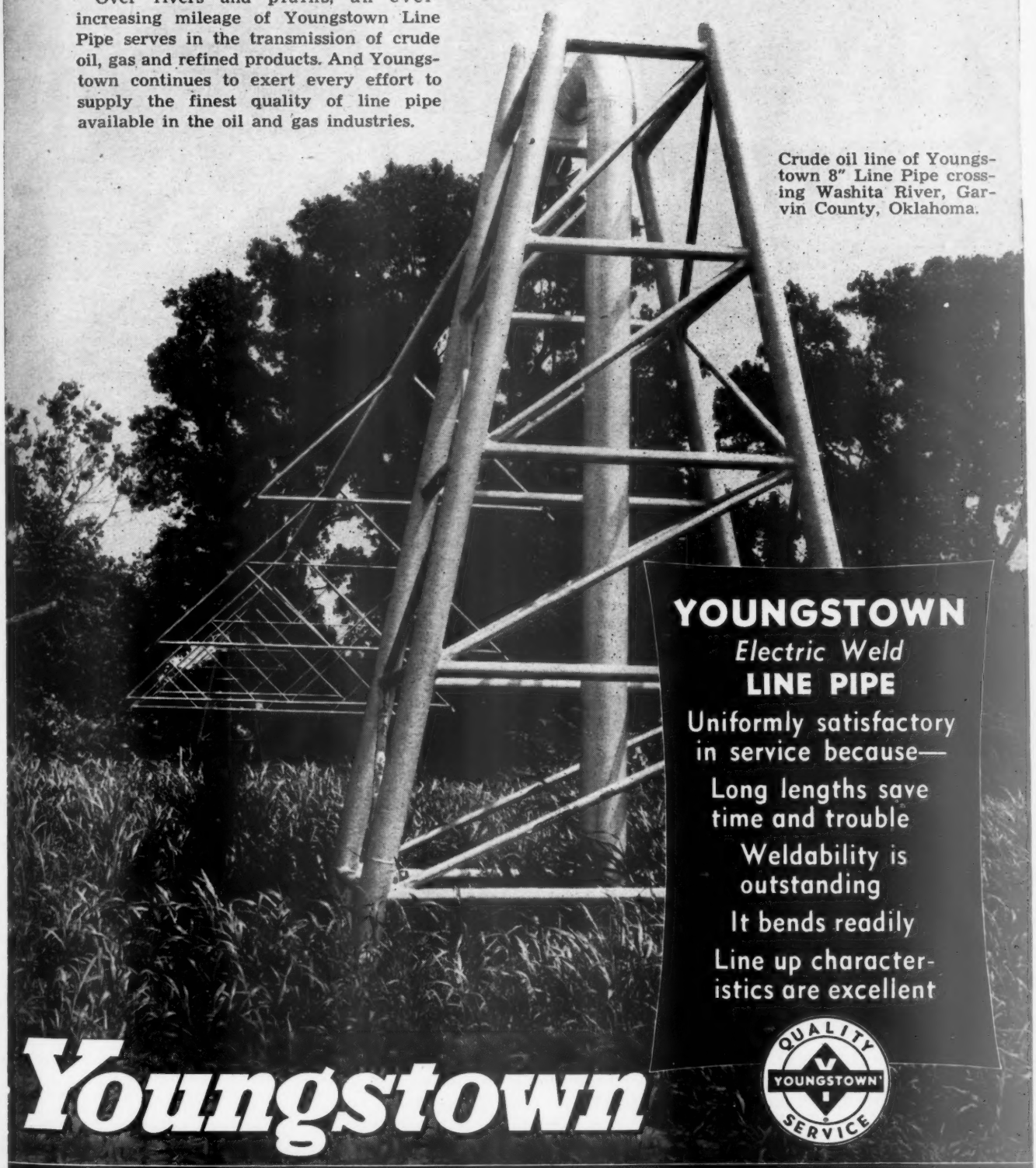
Yes, it's Youngstown

Over rivers and plains, an ever-increasing mileage of Youngstown Line Pipe serves in the transmission of crude oil, gas and refined products. And Youngstown continues to exert every effort to supply the finest quality of line pipe available in the oil and gas industries.



Crude oil line of Youngstown 8" Line Pipe crossing Washita River, Garvin County, Oklahoma.

YOUNGSTOWN
Electric Weld
LINE PIPE

Uniformly satisfactory in service because—

Long lengths save time and trouble

Weldability is outstanding

It bends readily

Line up characteristics are excellent

QUALITY YOUNGSTOWN SERVICE

Youngstown

THE YOUNGSTOWN SHEET AND TUBE COMPANY
Manufacturers of Carbon, Alloy and Yoloy Steel

General Offices: Youngstown, Ohio - Export Office: 500 Fifth Avenue, New York 36, N. Y.

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES

NEW oil and gas Literature

- Brochures
- Bulletins
- Catalogs

For more information on items described here in brief, use the handy reply card and circle the corresponding numbers

(30) OXYGEN ANALYZER

Arnold A. Beckman, Inc., has released a four-page folder describing its Model 1A3B Dissolved Oxygen Analyzer. The analyzer consists of a gaseous phase oxygen analyzer (Model F3) and a scrubbing unit. These components are mounted and interconnected in a metal cubicle.

Circle number (30) on reply card.

(31) HEAT EXCHANGERS

A complete description of stock and specially engineered Young Radiator Company Type "F" Fixed Tube Bundle Heat Exchangers is given in its newly revised Catalog No. 1254. The 12-page two-color catalog also contains application photographs covering a wide range of industries. It includes materials and construction features, dimension drawings and tables.

Circle number (31) on reply card.

(32) TESTING EQUIPMENT

"Testing Equipment for Control Water Analyses" is a new 12-page bulletin published by W. H. and L. D. Betz. Bulletin describes the complete line of Betz Titration Stands and test sets, Betz Cabinets and test sets the Betz Conducto Bridge, Colorimetric Comparators, and the Betz Photometer.

Circle number (32) on reply card.

(33) STRAINERS AND VALVES

Catalog Section 12-T on relief valves and strainers, which includes newly designed union bonnet strainers in sizes 1¼ to 2 in. inclusive, has been published by Edward Valves, Inc. Besides dimensions and design details for Edward forged steel strainers and relief valves, this new catalog section contains tips on the installation and maintenance of these "specialties."

Circle number (33) on reply card.

(34) PUMPS

Peerless Pumps has published a 12-page bulletin on its Hydro-Line of pumps. Both Process and Transfer types are described in the bulletin. Cut-away views show the construction of the pumps. Photographs of various types of Peerless pumps in different type operations are also contained in the bulletin.

Circle number (34) on reply card.

(35) INTERNAL PURIFIERS

An internal type purifier (scrubber) for delivering clean vapor and gases from steam drums, flash tanks, evaporators, packed towers, bubble-cap towers, deodorizers, and stills, is described in a four-page, two color bulletin released by the V. D. Anderson Company. Folder contains dimensional drawings illustrating the use of purifiers inside two typical installations, steam drums, and bubble-cap towers.

Circle number (35) on reply card.

(36) AIR COMPRESSOR

A colorful two-page bulletin has just become available on the Le Roi 105 cfm utility air compressor. Installation drawings on the new literature show that the width is 25 in. and the overall length is only 82 in. Photos show the compressor with and without the removable lightweight expanded metal hood sides. Specifications for the compressor and engine are included.

Circle number (36) on reply card.

(37) AUTOMATION

The "Tools of Automation," a new 12-page booklet issued by Reliance Electric and Engineering Company, expresses the company's philosophy of combining applied engineering, creative thinking, and electric motor drives to provide the "know-how" for automation of single machines or continuous processes. Illustrations and sketches accompany each section to help tell the automation story.

Circle number (37) on reply card.

(38) FITTINGS, RODS

W. C. Norris Manufacturer, Inc., has published three new bulletins: Fittings, Sucker Rods, and Wellhead Equipment. Fittings bulletin covers swaged nipples, bull plugs, and other tubular items. Norris and Hinderliter wellheads, as well as auxiliary items, are described in the wellhead equipment bulletin. Sucker rod bulletin outlines the history of company in the sucker rod field, and furnishes information on the four types of rods now manufactured by Norris.

Circle number (38) on reply card.

(39) TRANE PRODUCTS

The Trane Company has announced its revised product bulletin PB-290 is now available upon request. All new products, as well as existing ones with improvements are covered both editorially and pictorially.

Circle number (39) on reply card.

(40) PNEUMATIC HANDLING

A 16-page, 2-color bulletin on bulk pneumatic handling has been released by the Fuller Company. Entitled "How to Pull Dollars Out of Thin Air," bulletin D-2 tells how handling costs can be reduced substantially by using the proper pneumatic handling system. Also covered are the Fuller rotary compressor, the clinker cooler, and the new kiln preheater.

Circle number (40) on reply card.

(41) WIRE ROPE

Bulletin No. 5448, called "Ropeology," published by Macwhyte Company shows special boat slings, barge tow line, logging operation, cable assemblies, slings and aircraft cable. Four-page catalog contains photographs of various ropes and assemblies in use.

Circle number (41) on reply card.

(42) AUTOMATIC REGULATORS

A four-page, illustrated bulletin showing a selection of automatic regulators designed for use in the heating, power-generating and industrial processing fields has been made available by Atlas Valve Company. Eleven automatic regulating devices are pictured and described.

Description of each unit covers the maximum and minimum pressure limits, materials and construction, design features, and recommended applications.

Circle number (42) on reply card.

(43) SR-4 LOAD CELLS

Instrumentation Data Sheet No. 10.18-7 describes the use of Baldwin SR-4 load cells in conjunction with Minneapolis-Honeywell ElectroniK instruments for tank, bin, and hopper weighing. Design considerations and tips on instrument selection are included.

Circle number (43) on reply card.

(44) OXYGEN PLANTS

Dresser-Stacey Company has issued Bulletin 0-50 describing its oxygen plants and processes. Photographs and a flow-chart illustrate the bulletin.

Circle number (44) on reply card.

(45) CENTRALIZERS

Larkin Packer Company, Inc., has prepared and has ready for distribution a 4-page folder on centralizers. The folder discusses the 20 types and 4 ranges available and includes price data.

Circle number (45) on reply card.

(46) FILMS

A catalog released by United States Steel lists the motion pictures currently being sponsored and distributed by the company. Catalog includes two new motion pictures, "Iron Ore from Cerro Bolivar," a film on the discovery and development of a new iron ore mine in Venezuela, and "The Waiting Harvest," a film on United States Steel's role in the production of basic chemicals from coal.

Circle number (46) on reply card.

(47) INSTRUMENTATION

A 12-page general catalog with illustrations, descriptions, and basic specifications of Fischer and Porter Company's line of process instrumentation has been made available. Instrumentation for measuring and controlling process variables includes: Variable-area and variable-head flow meters; pressure instruments, temperature instruments; liquid level instruments; density and specific gravity measuring instruments; viscosity and consistency instruments; electric, pneumatic, and electronic transmitting, recording and controlling instruments and air-operated control valves.

Circle number (47) on reply card.